

The AMSAT[®] Journal



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Volume 28, Number 5

September/October 2005



Suitsat is ready!



A \$5 S-band downconverter.

SuitSat School Spacewalk Pictures, Artwork and Signatures from Students around the world



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Bequest

A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA

AMSAT Journal Opening

After long service to AMSAT, John Bubbers, W1GYD, is retiring as a member of *The AMSAT Journal* staff. John has provided a great deal of talent to the Journal including translation of articles from German from our friends at AMSAT-DL. A number of those articles were included in past issues of the Journal. I would like to sincerely thank John for all the help he has given me.

John is going to leave the staff on January 1 and we'll need to replace his talents. If you would like to serve on *The AMSAT Journal* staff please let me know. You do not need to be able to translate articles but you should be able to proofread and provide correction comments to the Editor during composition of each issue. Please contact me at wa4swj@amsat.org if you're interested.

Ed Long, WA4SWJ, Editor, The AMSAT Journal. ☎

SSETI Express

The SSETI Express Mission News Page at <http://sseti.gte.tuwien.ac.at/WSW4/MOPWS/news> has been updated with the latest news and pictures from Plesetsk.

The Download Page at <http://sseti.gte.tuwien.ac.at/WSW4/MOPWS/downloads.php> contains software for radio amateurs to enable them to make use of the spacecraft along with the launch campaign logbook.

The latest versions of the English and French editions of the SSETI Express Handbook can be downloaded from <http://www.uk.amsat.org/>.

AMSAT-UK produces a newsletter "Oscar News" full of satellite information. For membership details contact the secretary Jim Heck, G3WGM.

Tel: +44 (0)1258 453959
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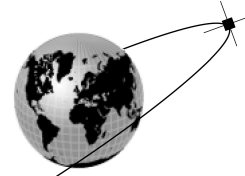
73,
Trevor, M5AKA ☎

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other



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The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPEG formats. AMSAT-NA reserves the right to select material for The AMSAT Journal based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce The AMSAT Journal.

This past week AMSAT conducted three meetings of critical importance to the AMSAT membership; the annual Board of Directors meeting, the annual Meeting of the Corporation and the third plenary meeting of the Eagle satellite design team.

Board of Directors Meeting

The Board of Directors met on Thursday and Friday, October 6-7, 2005. The agenda was packed with important topics that will be fully described in the minutes that I expect will be published in the next issue. The first order of business was to recognize the new and returning members of the Board and for the Board to elect the officers. As a result of the recent elections, I would like to congratulate the two new members of the Board of Directors, Emily Clarke, W0EEC, and Bob McGwier, N4HY, First Alternate. Thus, your Board for the coming year is as follows:

AMSAT Board of Directors

Richard Hambly, W2GPS

Barry Baines, WD4ASW

Gunther Meisse, W8GSM

Dr. Thomas A. Clark, W3IWI

Lou McFadin, W5DID

Paul Shuch, N6TX

Emily Clarke, W0EEC

Bob McGwier, N4HY (First Alternate)

Lee McLamb, KU4OS (Second Alternate)

The officers are the same as last year except that Stan Wood, WA4NFY, has retired as VP of Engineering. AMSAT thanks Stan for his years of service in this important capacity. We welcome and congratulate Bob McGwier, N4HY, as the new AMSAT Vice-President of Engineering. Thus, your officers for the coming year are:

AMSAT Officers

Richard Hambly, W2GPS, President

Lee McLamb, KU4OS, Executive Vice President

Mike Kingery, KE4AZN, Vice-President Operations

Frank Bauer, KA3HDO, Vice President of Human Spaceflight

Bob McGwier, N4HY, Vice-President of Engineering

Barry Baines, WD4ASW, Vice-President Marketing and User Services

Steve Diggs, W4EPI, Secretary

Gunther Meisse, W8GSM, Treasurer

Martha Saragovitz, Manager

Annual Meeting of the Corporation

The Annual Meeting of the Corporation, often referred to as the Annual General Membership Meeting, was held on Friday evening, October 7, 2005. The annual AMSAT Symposium had been cancelled due to the pair of hurricanes that devastated the Gulf Coast of the U.S.A. so there were relatively few AMSAT "general members" in attendance. Because of this we conducted an experiment by broadcasting the meeting over the AMSAT EchoLink conference and took questions using EchoLink's text messaging service. There were participants from about 12 countries and questions were relayed to me by AMSAT Board members Dr. Tom Clark, W3IWI, and Emily Clarke, W0EEC, who worked to make sure every question was asked and answered. This was so successful that AMSAT will expand the use of the Internet for future meetings.

The messages presented to the membership reflected the President's letter sent out to the membership just before the meeting via the AMSAT News Service. That material is repeated here for those who rely on the Journal for their information about AMSAT.

I have been reviewing the accomplishments of the past year and the challenges of the coming year. I am pleased with the progress of AMSAT's organizational and infrastructure improvements and with the progress of the two satellite projects, P3E and Eagle. For the coming year I am committed to focus AMSAT's activities primarily on the completion and launch of P3E, the construction of the Eagle space frame and implementation of the Eagle Software Defined Transponders (SDX) at a minimum.

The changes in AMSAT's organizational structure have created many new opportunities for members to actively contribute to the growth and advancement of our organization. Our members are working on teams that are dedicated to areas of excellence such as finance and fundraising, marketing and field operations, technical and scientific, office management, external affairs, operations, human spaceflight and record keeping. We have a great group of volunteers working in these areas and there is always room for more people.

... continued on page 15



On Thursday, September 8 at 13:08 UTC, Progress 19P lifted off from the Baikonur Cosmodrome in Kazakhstan. Included in the 2.5 tons of fuel, food and supplies are two Amateur Radio on the International Space Station (ARISS) systems - the Suitsat Amateur Radio hardware and the Slow Scan Television (SSTV) hardware and software. The successful docking of Progress to ISS on September 10 culminates the successful design, development, certification and delivery of these two ARISS Projects. The ISS Expedition 11 crew will unpack this equipment, making it available for installation, use and deployment by the Expedition 12 crew.

The Suitsat Amateur Radio system, coupled with a school artwork project, is planned to be installed in an outdated Russian Orlon spacesuit. It will then be deployed from the ISS during an Extra Vehicular Activity (EVA, or spacewalk). This is expected to occur in the December timeframe by the Expedition 12 crew. The Suitsat Amateur Radio system will beam down special messages and an SSTV image from within the Orlon space suit as it floats in space. The Suitsat radio system will allow hams and students to track the suit and decode special international messages, space suit telemetry and a pre-programmed Slow Scan TV image through its specially-built digital voice messaging system and Amateur Radio transmitter. As built, Suitsat will be a transmit-only capability that will run on the space suit's battery power.

As part of the Suitsat project, a CD with hundreds of school pictures, artwork, poems and student signatures is included. Two identical CDs were flown, one will go in the suit and the other will be for the crew to review. Using the crew CD, we hope to downlink these images using the SSTV system that will be located inside the Service Module once it is operational. There are approximately 300 items on the CD. These are from all over the world (Japan/Asia, Europe, Russia, Canada, US, South America and Africa). Several NASA Explorer Schools participated as well as numerous ESA and Russian Space Agency-sponsored schools.

The idea for Suitsat was first conceived by the ARISS-Russia team, led by Sergey Samburov, RV3DR, and was extensively discussed at the joint AMSAT Symposium/ARISS International Partner meeting in October 2004. The project, also called

Radioskaf or Radio Sputnik in Russia, is being led by project manager A. P. Alexandrov and Deputy Project Manager A. Poleshuk from RSC Energia, located in Korolev (Moscow area) Russia. On the US side, the hardware project development was led by AMSAT member Lou McFadin, W5DID.

Since October 2004 the Suitsat design concept matured and evolved due to the challenging development time constraints. In a very short timeframe, the ARISS international team designed built and tested a simple, yet fully featured system that we hope will inspire hams and students around the world.

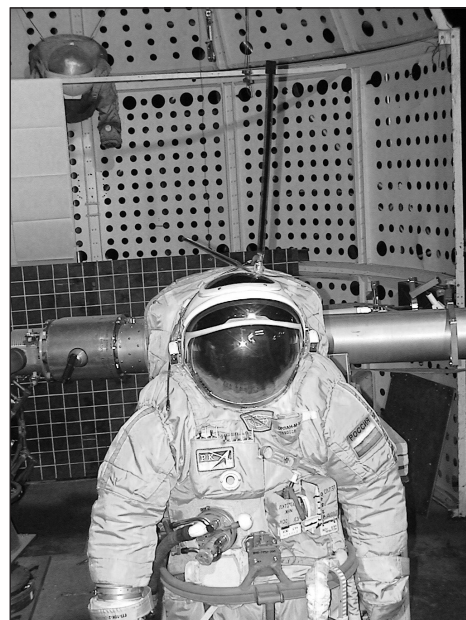
The SSTV system will be installed inside the Service module as an integral part of the ARISS Amateur Radio system. It will transmit and receive (JPG) still images from the International Space Station in a format called Slow Scan TV (SSTV). When fully operational, the SSTV system is capable of sending up to 480 images per day from ISS. It will also be able to receive images from Amateur Radio stations on Earth. This system will utilize the already installed Kenwood D-700 radio and the ARISS antennas mounted on the Service Module. The SSTV equipment flown on Progress 19P includes the SpaceCam software, a radio/computer interface module, and data cables. The dedicated laptop for SSTV operations will be launched on a subsequent Progress vehicle.

Over the course of the past several months, the Suitsat and SSTV system passed the stringent NASA and Energia safety certification process and were deemed ready for flight, clearing the way for the incorporation into the Progress 19P vehicle. More information on SSTV and Suitsat will be provided as we get closer to installation and deployment.

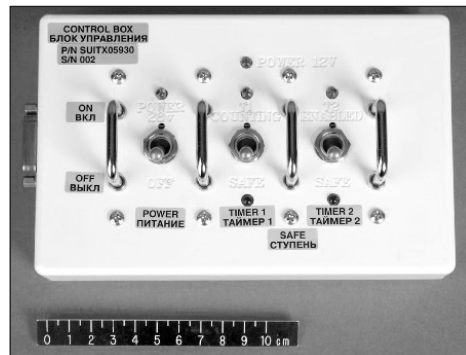
On behalf of the ARISS International team, I want to congratulate the Suitsat hardware development team and the SSTV development team on a job well done. We look forward to future operation of these systems on ISS, inspiring the next generation of space explorers.

Congratulations!!!!

Frank H. Bauer, KA3HDO
ARISS International Chairman
AMSAT V.P. for Human Spaceflight Programs
NASA ARISS Program Manager



Suitsat antenna.



Suitsat control box.



SSTV module.



Suitsat unit at Microchip.

AMSAT Eagle Update

James A. Sanford, PE, WB4GCS,
wb4gcs@amsat.org
Eagle Project Manager

We were all saddened by the horrific damage to the Gulf Coast. AMSAT's sacrifice, the 2005 Symposium, seems small by comparison. I'm proud to see the high profile role that Amateur Radio has continued to play in emergency communications and recovery. As I watched the news, I couldn't help but think about how Eagle will help similar efforts.

I piggy-backed an Eagle design review on to AMSAT's required Board of Directors meeting. I write this just two days after those meetings. We accomplished some good things in these intellectually and physically demanding sessions.

To begin with, some questions revolving around the combination of structure design and launch vehicle were resolved. We now know that the structure design is compatible with any of several probable launch opportunities. This is important news. We expect to show a structure model at Dayton in 2006.

We have settled on a set of standard module enclosures and sizes. Production of fabrication templates has already begun. Definition of module quantities is in progress and may be complete by the end of October.

We are evaluating options for the power system. There are some exciting new technologies that will be explored.

The software defined transponder (SDX) is maturing. Engineering models will be demonstrated in the next year.

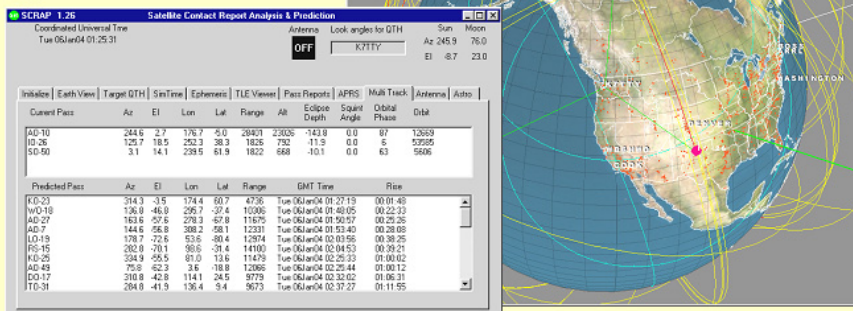
A substantive proposal for an affordable CC-Rider ground station was presented. Remember, the ground segment will be developed in parallel with the space segment. Our goal is affordable, small and portable – perfect for apartment dwellers and emergency situations.

We made significant progress in defining payload interfaces and a detailed design session will have occurred by the time you read this.

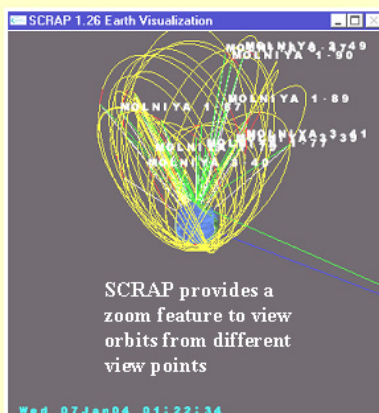
A fundamental tenet of the Eagle program is openness. I think that we can do better than we have. There are no hidden secrets, but I think we can communicate more effectively. Look for more information on the AMSAT Web site and elsewhere over the coming months.

Satellite Contact Report Analysis Prediction

AMSAT is now the North American distributor of SCRAP, a tracking program designed for ham satellite applications for Windows 95+

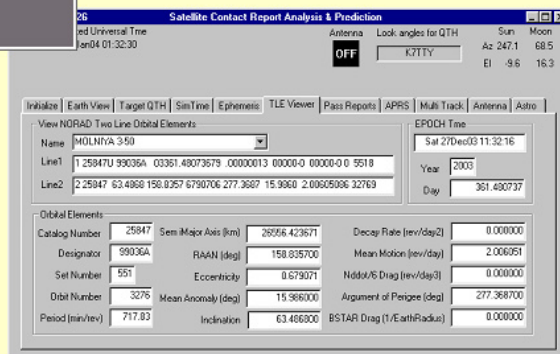


SCRAP provides a real-time contact report and display for over 2000 satellites on a Microsoft Windows 95+ Pentium platform.



Eleven panels provide for controlling functionality

1. Initialization
2. Earth View
3. Target QTH
4. Simulation
5. Ephemeris
6. TLE Viewer
7. Pass Reports
8. APRS display
9. Multi-Track display
10. Antenna rotor control
11. Astronomical prediction



SCRAP

is a product of the

Bytheway Software Development Lab (BSDL)

Price is \$50 for AMSAT members, \$60 for non-members, postpaid on CD-ROM. Order by calling 1-888-322-6728, or use the online shop at

<http://www.amsat.org>

The author, Bill Bytheway, K7TTY donated SCRAP to AMSAT. All proceeds support AMSAT.

Free software upgrades and further information can be found at

<http://www.rtty.com/bytheway>

As always, comments and questions to:

wb4gcs@amsat.org



A Simple 70cm Satellite Antenna

by Andrew Roos, ZS1AN, zs1an@qsl.net

An excellent talk on “Satellites for Beginners” by Dave Long, ZS5FR, at a recent hamfest has stimulated interest in low-earth orbit satellites amongst South African amateurs. I write a regular column called “Weekend Antennas” for our national magazine, *Radio ZS*, and decided to devote the next installment to a simple 70cm downlink antenna for mode V/U satellites (2m uplink, 70cm downlink) like AO-51.

The 70cm downlink is usually the more critical in terms of antenna requirements because the satellite’s transmitter is relatively low-powered and because path loss increases with frequency. The link budget for AO-51 published on the AMSAT Web site estimates the path loss for the 2m uplink to be 145dB and the path loss for the 70cm downlink to be 155dB. With the satellite’s transmitter operating at 1W output, an antenna gain of about 10 dBi is required to hear the satellite at its maximum range of 3,000km (1,900 miles). On the other hand, even with only a 5W transmitter, an antenna with no gain (0 dBi) would suffice for the uplink.

The antenna, a corner reflector, is particularly easy to construct because, unlike Yagis, almost all the dimensions are non-critical. The only critical dimension is the length of the driven element, which is simply adjusted for minimum SWR.

Figure 1 shows the electrical layout of the antenna. It consists of a driven element (wire number 12 in the diagram) backed

by horizontal and vertical reflectors. The horizontal-plane reflectors (wires 1 to 6) meet the vertical-plane reflectors (wires 7-11) to form a 90-degree “corner” at the bottom left of the antenna, which is why it is called a “corner reflector”. The reflector elements should be spaced not more than 1/8 wavelength apart, and should be at least 0.6 wavelengths long. However the exact length and spacing of the reflectors is not critical.

Construction

To build it you will need:

- A 1.8m length of 21mm x 21mm cross-section wood
- A 1m length of 19mm x 9mm cross-section wood
- 12 aluminum welding rods, approx. 3.2mm diameter and 50cm long
- A 90-degree corner brace
- Wood screws and two 6 x 50mm bolts with washers and nuts

Cut a 40cm piece from the 21mm x 21mm cross-section wood. Drill five 3.5mm holes in this piece, 8cm apart (from center to center), starting 1cm from one end and ending 7cm from the other end. The holes should be just large enough for the welding rods to fit snugly.

Drill six 3.5mm holes in the remaining 1.4m length of 21mm x 21mm, starting 1cm from one end, 8cm apart (from center to center). Attach the 40cm piece at right angles to the 1.4m piece using the 90-degree corner brace. The holes in the 40cm piece should be lined up with the last of the holes in the

1.4m length (see Figure 2).

Cut the 1m length of 19x9mm into two equal halves. Attach these diagonally between the vertical and horizontal members of the frame, one on either side of the frame, using 6x50mm bolts. The center of both the bolt holes should be 28cm from the bottom-left reflector element, which places the bolts mid-way between the forth and fifth reflector elements. Once the bolts are in place, cut these diagonal pieces flush with the sides of the vertical and horizontal members.

Drill 3.5mm holes through the center of both of the diagonal pieces. These holes support the driven element and it is important that they line up precisely, so it is best to drill both holes together. Cut one of the aluminum welding rods to exactly 29.8cm long, insert it through the holes you have just drilled so that the middle of the element is midway between the two diagonal members, and epoxy it into place.

Insert the 13 reflector elements into their holes and epoxy them in place. The exact length of the elements is not critical, provided they are at least 41cm long and are all about the same length. Mine came in 50cm lengths, so I used them like this.

Once the epoxy has cured cut a 5mm gap in the center of the driven element. Attach the coax shield to one side, and the braid to the other. Unfortunately ordinary solder does not bond aluminum effectively. I crimped a couple of lugs onto either side of the driven element, and soldered the coax to these and then covered the crimps with a layer of epoxy to shield them from the elements. Alternatively, if you can find some zinc/tin solder you should be able to solder directly to the aluminum.

Finally, coat the entire wooden structure with a couple of coats of wood seal, varnish or paint to waterproof it.

If you have access to an SWR meter or antenna analyzer that works on the 70cm band, then you can trim the driven element for minimum SWR (in this case, it might be wise to start with a 31cm driven element). Since I didn’t have access to a suitable SWR meter, I just cut the element to exactly 29.8cm and checked that my 70cm rig was able to put full power into it through the entire band, so the SWR can’t be too bad! Unlike other directional antennas, the element lengths

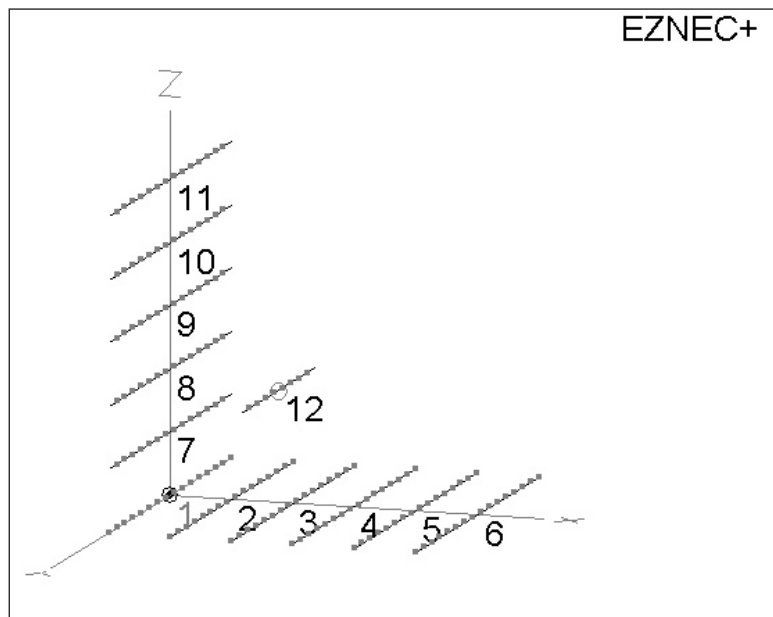


Figure 1 – Layout of the Corner Reflector.

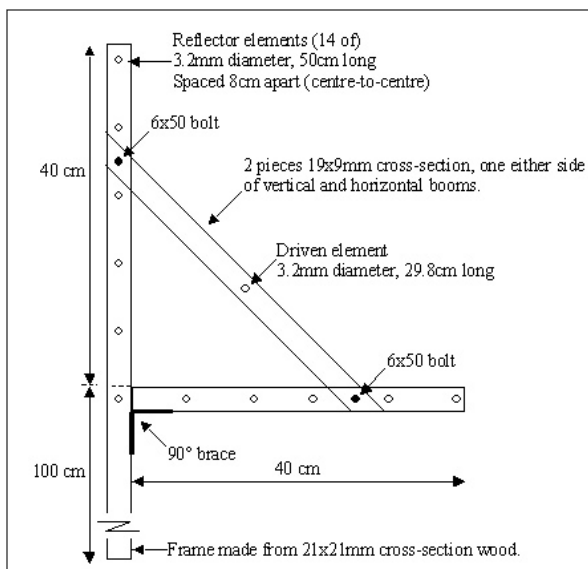


Figure 2 - Construction details.

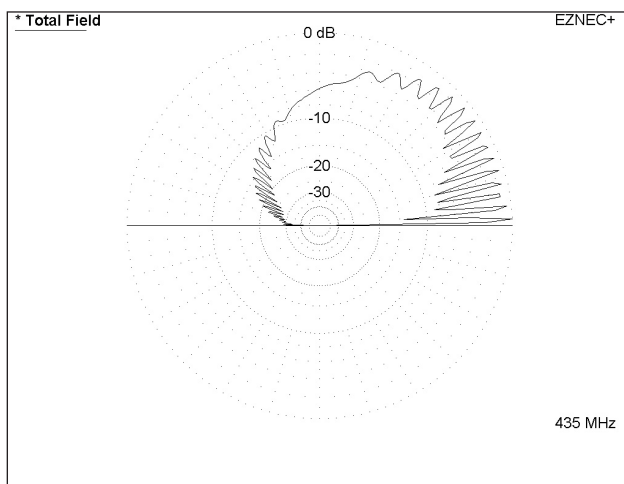


Figure 3 - Elevation pattern at 435MHz mounted 5m above ground.

are not critical, so provided the radio is able to deliver power into the antenna, you can be confident that the antenna will function correctly.

Performance

Figure 3 shows the elevation pattern of the antenna when it is mounted 5m above ground.

Maximum gain is 10.36 dBi at an elevation angle of 2 degrees. However as you can see, the antenna provides significant gain at all elevation angles up to 90 degrees, which is ideal for satellite work. There is some variation in gain due to ground reflections, but this is much less pronounced than it is for most horizontally-polarized antennas, thanks to the effect of the horizontal reflector plane immediately below the driven element.

Figure 4 shows the azimuth pattern at an elevation angle of 30 degrees. Maximum gain is 9.8dBi, the -3dB beam width is

85 degrees and the front/back ratio 20 dB.

Note that the antenna is horizontally polarized. Those familiar with satellite operation may ask whether a circularly-polarized antenna would not be a better choice. Well, yes and no. If you know the polarization of the received signal, then a circularly polarized antenna with the correct handedness (right-hand or left-hand) would be ideal. However in the case of AO-51 there are two UHF transmitters, and to maximize the isolation between the antenna systems, one uses left-circular polarization (LCP) while the other uses right-circular polarization (RCP). Typically, the LCP antenna is used for the digital downlink and the RCP antenna for the voice downlink, although this is configuration-dependent. So the ideal solution would be to have two antennas, one LCP and one RCP, or a single antenna with switchable

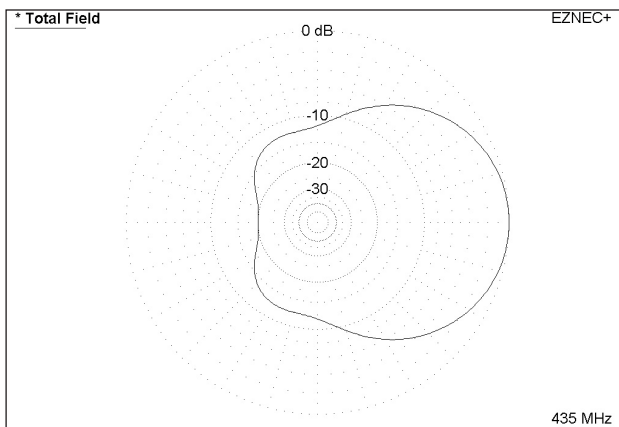


Figure 4 - Azimuth pattern at 30 degrees elevation.

polarization. However this would add substantial additional complexity, so I chose instead to use linear polarization and accept the 3 dB penalty that this will give with a circularly polarized signal of either handedness. This was taken into account when calculating the required gain.

The finished antenna is small and light enough to be turned using a television antenna rotator or to be hand-held. It can be turned on its side to give vertical polarization for repeater use, or can be tilted downwards by 45 degrees so the two reflector planes are 45 degrees above and below horizontal to maximize low-angle radiation for terrestrial weak-signal work. I mounted mine on an ancient Hy-Gain AR-22XL rotator and have started happily exploring the wonderful world of satellites. 📡



Figure 5 - The finished antenna.

The AMSAT Video Services Project and YOU

Don Jacob, WB5EKU, wb5eku@amsat.org

Director of AMSAT Video Services

The AMSAT Video Services project was created to help keep the satellite community abreast of current activities. It presents us with the unique opportunity to provide the membership with more information directly from officials and project managers with little or no additional burden on their already full schedule.

We want to add to that list operational activities, educational and tutorial topics -- the list can go on to the limits of our imagination. What is needed is "content, content and more content". So far we have been able to produce the NewsReels with the material Gunther, W8GSM, shot at Space Day in Washington D.C. and The Dayton Hamvention this year. By the time you read this we will have more on the Web site from the AMSAT Meeting in Pittsburgh. We can't be at every hamfest, Field Day, Cub and Boy Scout activity or satellite demonstration. This is where **you** come in. We need more content and you can help provide it. When you attend your local hamfest, satellite demo, club meeting presentation, ISS School contact, etc., bring a camcorder along. Shoot what you can (shooting tips later in the article) digital still pictures can be used to augment the video and audio. Get kids involved; they love to be in "movies", they love to talk to satellites. There are many operational activities that are for kids at club outings, encourage them to participate, then get them on tape!

OK, now you have your camera at the event you want to shoot, what do you do now? Here are a few tips that will make your video more useable when the editor (me!) receives it. Beforehand always shoot wide shots of the area so the viewing audience knows what they are looking at (this is called an establishing shot). If equipment is to be demonstrated, get full screen shots of the equipment so it can be edited into the demo. When its time for the event to start do not set the camera up at the back of the room, especially if you are only using the microphone in the camera. Audio is just as important as the video. Get the camera as close as practical to the speaker and in the direction that the speaker will be looking. Try not to get a profile shot, after a few seconds on the screen a profile becomes very boring to watch.

Keep the subject centered in the viewfinder

frame. You will probably have to operate the camera for most of the talk to keep them in frame as speakers tend to bob, weave and wander around. At a demonstration shoot, keep the demo framed wide enough to see the action, but not so wide as to lose the meaning of what is being shown.

Before or after the event/demo, get some tight shots of equipment/material, people watching or operating etc. Shoot a lot of video, tape is relatively inexpensive. As a rule of thumb, if you think you have enough footage -- shoot more. It is much better to have more footage than necessary to tell your story. Also, shoot the video, as you would want to view it. Make your pan shots (side to side or action following) as smooth as possible. The same goes for tilting (up-down). Jerky or fast movement of the camera makes a poor shot and very hard to edit around. Think of what you want the final product to look like when it is finished and viewed.

OK, now you have the videotapes ready to send off, what now?

Documentation

Please include as much information about what is on the tapes as possible. Names and call signs of amateur operators or titles where appropriate. Double check the spelling of names, places, call signs etc. The old adage -- who, what, when and where definitely apply here.

To digress slightly, we will accept most types of videotape. MiniDV, DV, Digital8, Hi8, VHS and 8mm. Other formats can be accommodated, but it is advisable to ask in advance. The quality of the analog formats, VHS, Hi8 and 8mm will not look as good as the digital formats, but it would be better to have them than no video at all.

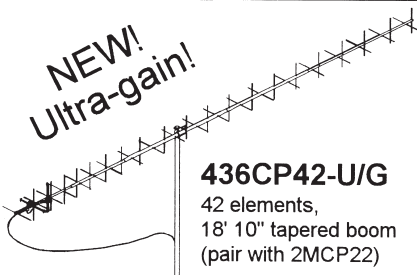
When you have your tape/documentation package ready, send me an email at wb5eku@amsat.org describing what tape format you have and the event, I'll reply with shipping instructions. I'll also make a dub of the tape and return your original to you.

What else can you do? If you have any experience with video, audio, editing or just want to help out, remember this is a volunteer organization -- VOLUNTEER!

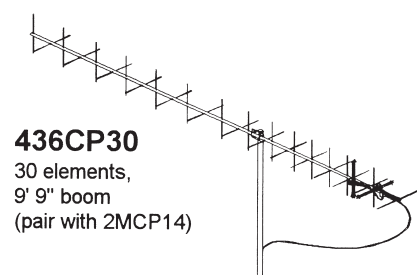
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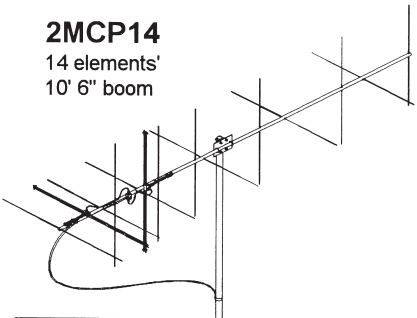
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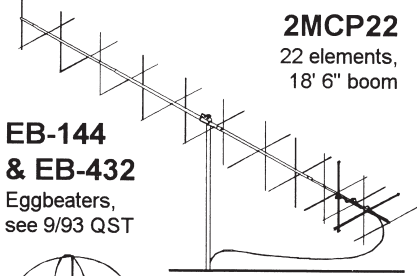
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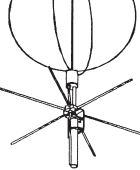


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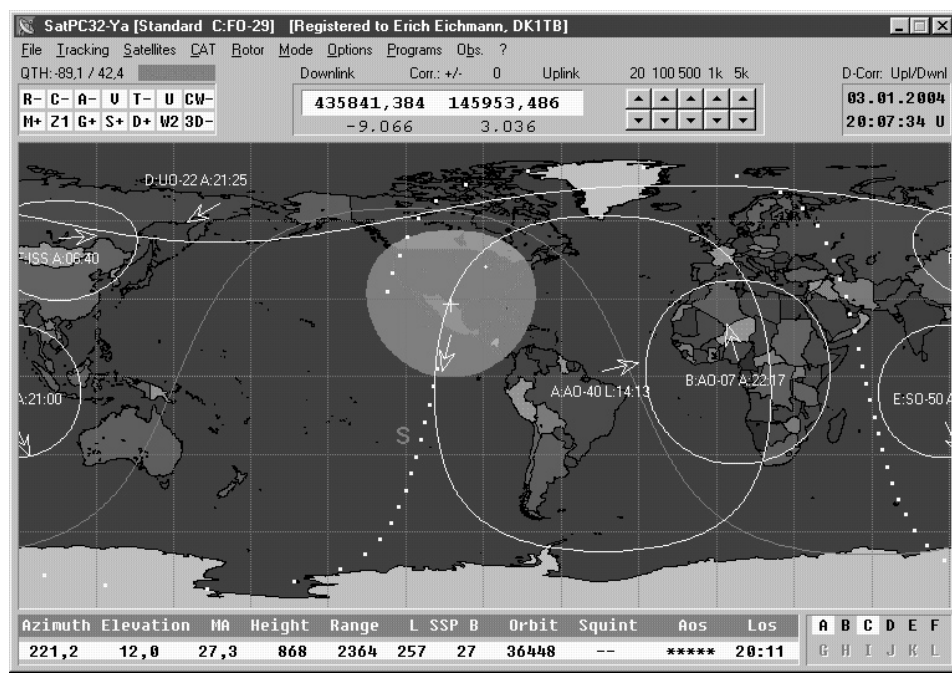
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The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



A \$5 Mode V/S Adapter

Anthony Monteiro, AA2TX, aa2tx@amsat.org

Introduction

The recently launched AMSAT Echo Satellite, AO-51, introduced the use of transponder mode V/S. Mode V/S uses the VHF (2-meter) band for the uplink and S-band (2.4 GHz) for the downlink. Equipment for this new mode is an issue because most commonly available S-band down-converters convert to the VHF band for the intermediate frequency. But most transceivers cannot use the same band for both the uplink and downlink at the same time. Operating on mode V/S has required using a second radio or buying a special down-converter that uses the UHF band for the intermediate frequency.

It can be easily constructed for about \$5 in parts and does not require any test equipment.

Design Considerations

S-band down-converters are available in two basic types. There are those originally designed for MMDS¹ and those specifically designed for Amateur Radio service. The units designed for Amateur Radio use generally provide the IF output at around 145 MHz. The MMDS units provide the IF at around 123 MHz, although some vendors modify these so the output is at 145 MHz. In any case, the two common intermediate frequencies are at 123 MHz and 145 MHz.

A typical S-band down-converter has a large

are widely available are not quite what is needed to convert from VHF to the 6-meter band. The required local oscillator signal needs to be in the 70 – 100 MHz range. Some manufacturers will make custom clock oscillators at these higher frequencies but they are much more expensive. Fortunately, standard TTL clock oscillators at half the needed local oscillator frequencies are readily available.

Instead of using a frequency doubler on the output of the clock oscillator, the adapter uses a sub-harmonic mixer circuit. A sub-harmonic mixer internally doubles the applied local oscillator frequency before mixing it with the RF input signal. Sub-harmonic mixers are widely used at the upper microwave range when it is often difficult to generate a local oscillator signal at the desired fundamental frequency. These microwave mixers generally use special, matched Schottky-diodes. But at VHF frequencies, a pair of ordinary 1N914 silicon switching diodes can be used. The diodes are connected *anti-parallel* to create the desired frequency doubling action.

Using a sub-harmonic mixer with a TTL clock oscillator to directly generate the local oscillator signal is much simpler and cheaper than the typical crystal oscillator/multiplier chain and dramatically reduces the overall complexity and cost of the adapter. It also eliminates the need to tune any multiplier stages and the adapter was designed so that no tuning or test equipment is needed.

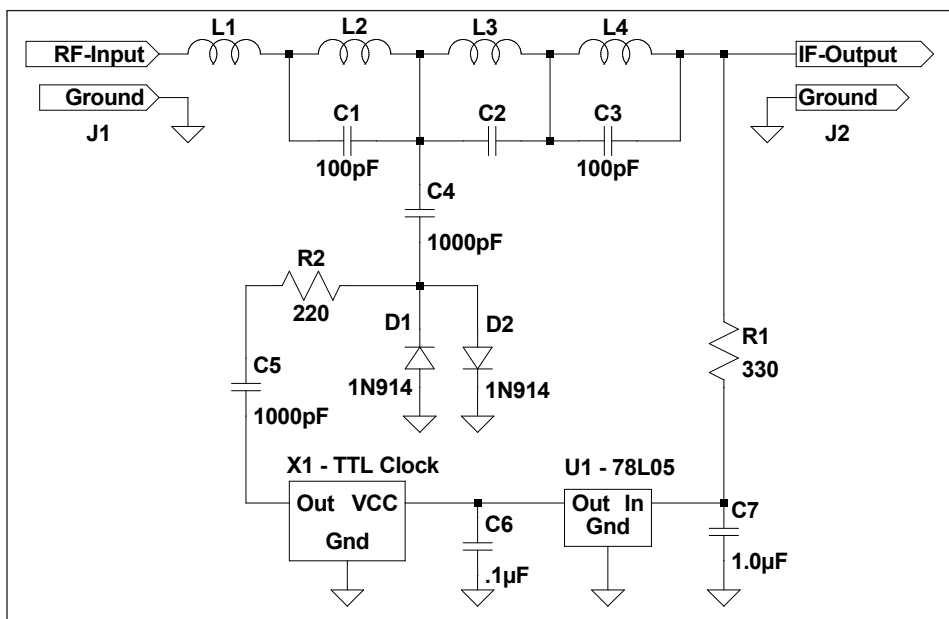


Figure 1: Schematic diagram

This article introduces an alternative solution that is simple and inexpensive. It shows how to build an adapter that will convert the output of an S-band down-converter to the 6-meter band. The 6-meter band is ideal because there are no satellite up or down link allocations in this band and so there can be no mode conflicts. This adapter will work with the FT-847, TS-2000, IC-706, IC-746, FT-817, FT-857, FT-897, FT-100 and probably many other radios as well. The use of 6-meters for the down-converter also eliminates a conflict when attempting to use L-band, up-converters as they typically use the 2-meter VHF band for the intermediate (IF) frequency as well.

The adapter uses inexpensive, commonly available components and a very simple

amount of overall gain. Usually, an external attenuator is needed to bring the signal levels down to more reasonable levels. Without an attenuator, the receiver S-meter will provide a high reading even if there are no input signals. The popular TransSystem AIDC-3731AA for example, has 37 dB of gain. To use this down-converter, a 15 dB (or more) attenuator is generally needed to bring the S-meter reading back down to near S-0 with no input signal. This means that an adapter can have a significant amount of conversion loss without impacting the overall receive system performance.

TTL clock oscillators are widely available and very inexpensive (about \$1) at certain standard frequencies up to around 66 MHz. Unfortunately, the standard frequencies that

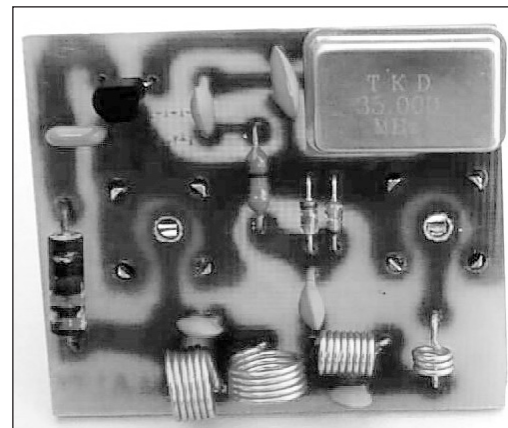


Figure 2: Component side of adapter prototype

Circuit Description

The schematic diagram is shown in Figure 1. There are two versions of the adapter. The 123 MHz version is for use with MMDS down-converters and the 145 MHz version



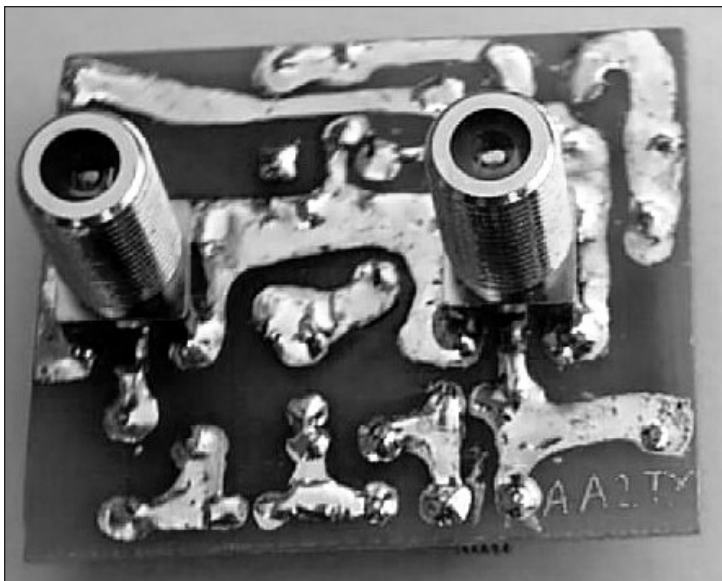


Figure 3: Solder side of adapter prototype showing F-connectors

is for use with Amateur Radio down-converters. The circuits are the same but the inductor values and the TTL clock oscillators are unique. Also, capacitor C2 is not used in the 123 MHz version.

The down-converter output is connected to the adapter *RF-Input* port and the down-converter's power inserter is connected to the adapter *IF-Output* port. The *IF-Output* port provides the 6-meter signal to the station transceiver.

The input filter consisting of L1, L2, and C1 presents a very high impedance at the IF frequency and isolates the RF input port from the IF output port. At the RF input frequency, the filter provides a low impedance path to the mixer diodes through capacitor C4 which provides DC isolation.

Inductors L1 through L4 provide DC conductivity through the adapter so the power inserter DC voltage appears at the *RF-Input* port to power the S-band down-converter. This DC voltage is also fed through resistor R1 to a 78L05 5-volt, linear, voltage-regulator (U1.) The voltage regulator and filter caps C6 and C7 provide +5 VDC for the TTL clock oscillator.

The TTL clock signal is fed through DC blocking capacitor C5, and resistor R2 to the 1N914 mixer diodes D1 and D2. The diodes mix the RF input signal with twice the TTL clock frequency and create the 6-meter intermediate frequency.

The output filter, consisting of L3, L4, C2 and C3, provides a low-impedance path at the desired 6-meter output frequency and rejects the local oscillator

fundamental frequency.

Components

The four coils are made by winding #22 gauge, enameled magnet-wire on a drill bit. The wire should be wound as tightly as possible with no space between turns. Tables 1 and 2 provide the coil winding information. Note that the #22 gauge magnet wire is available in a magnet wire kit at *Radio Shack* stores as well

as from many other vendors.

The remaining components are listed in Table 3. These components were specifically selected for their wide availability and low cost. Many of these can be found in even the most meager "junk-box."

The TTL clock oscillator and 78L05 voltage regulator are available from *Jameco*² in single quantities for \$1.19 and \$0.27 respectively. The PC mount F-connectors are available from *All Electronics*³ for \$0.50 each in single quantities. Many other vendors carry these parts as well.

Construction

The prototypes were constructed on single-sided, printed-circuit (PC) boards. The board layout is not critical and the prototypes were made by first drilling the component holes with a small drill and then drawing the circuit

traces with a *Sharpie*TM magic marker. A photograph of the completed prototype is shown in Figure 2.

The prototypes used PC mount, female F-connectors mounted on the bottom (copper) side of the PC board as shown in the photograph of Figure 3 so that the unit could be mounted in a small enclosure using 3/8" nuts on the connectors.

The adapter circuit is not very critical and as long as the lead lengths are kept short, perf-board, "dead-bug" or terminal-strip construction could also be used. It is important however to make sure that adjacent coils are at right-angles to each other to minimize stray coupling as can be seen in Figure 2.

Operation

The Mode V/S Adapter is connected between the power inserter and the down-converter as shown in Figure 4. The adapter has a conversion loss of around -15 dB. This should eliminate the need for an external attenuator.

The AO-51 S-band downlink is at 2401.200 MHz. When using the 123 MHz version, the downlink will appear at 53.200 MHz and when using the 145 MHz version, it will appear at 45.200 MHz but remember to include the Doppler-shift when looking for the satellite signal.

When using computer control, it will be necessary to change the receiver converter parameter in your software's configuration file. For most tuning programs, this parameter would represent the down-converter local oscillator frequency and would be around 2278 MHz for a 123 MHz converter or 2256

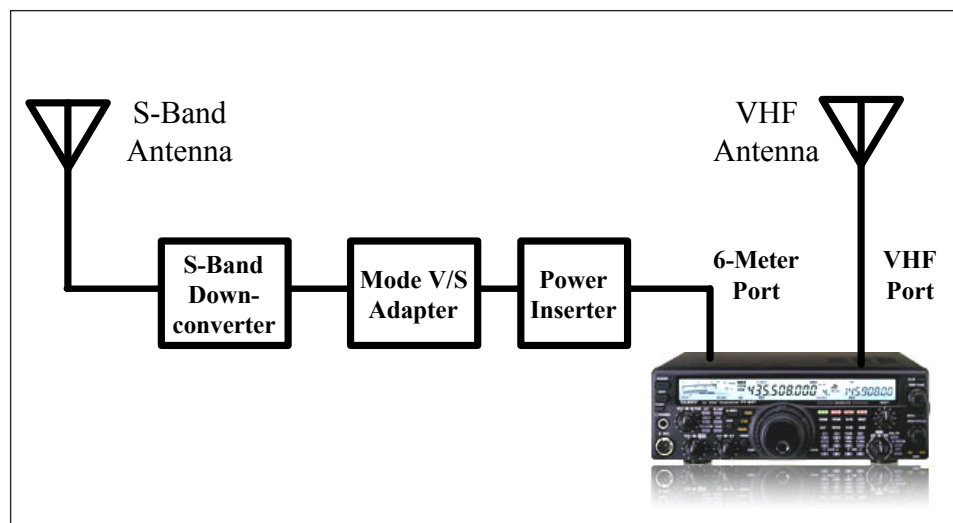


Figure 4: Connecting the Mode V/S Adapter



MHz for a 145 MHz unit. The Mode V/S Adapter adds a second level of conversion that acts like the local oscillator is 70 MHz higher for the 123 MHz version or 100 MHz higher for the 145 MHz version so add this to the original parameters. The new parameters would be around 2348 MHz for the 123 MHz version and 2356 MHz for the 145 MHz version.

The Mode V/S Adapter was tested *on-the-air* using a 2'x 3' grid dish, an AIDC-3731AA down-converter and an FT-847 transceiver. For transmitting, an omni-directional 2-meter antenna was used. *InstantTrack* with *InstantTune*⁴ software provided satellite tracking and automatic Doppler-tuning. With this setup, the signal from AO-51 exceeded S9 much of the time and it was quite easy to make several leisurely, albeit short, contacts on a satellite pass.

Summary

This simple and inexpensive Mode V/S Adapter converts the VHF output of an S-band down-converter to the 6-meter band. This enables many transceivers to be used to operate the AO-51 Mode V/S transponder without requiring an extra radio or a special down-converter with a UHF output. The adapter was tested *on-the-air* via several AO-51 contacts and it performed well.

Endnotes

¹ MMDS: *Multipoint Microwave Distribution System*, a type of wireless, cable TV service

² Jameco Electronics: www.jameco.com

³ All Electronics: www.allelectronics.com

⁴ *InstantTrack* and *InstantTune* software are available from AMSAT at www.amsat.org 

Coil	L1	L2	L3	L4
Inductance	13nH	120nH	100nH	160nH
Drill bit size	1/16"	1/4"	7/32"	1/4"
Turns	4	4	4	5

Table 1: Coil winding information for 145 MHz adapter

Coil	L1	L2	L3	L4
Inductance	21nH	91nH	160nH	210nH
Drill bit size	7/64"	1/8"	1/4"	1/4"
Turns	3	8	5	6

Table 2: Coil winding information for 123 MHz adapter

Component	Description
C1, C2*, C3	100pF 50V ceramic disc
*C2 is not used in the 123 MHz version	
C4, C5	1000pF 50V ceramic disc
C6	0.1uF 25V ceramic disc
C7	1.0uF 50V monolithic ceramic
D1, D2	1N914B silicon diode
R1	330 ohms, ½ Watt
R2	220 ohms, ¼ Watt
U1	78L05 5V, 100mA regulator (TO-92)
X1	TTL Clock Oscillator
	• 35MHz for 123 MHz version
	• 50MHz for 145 MHz version
J1, J2	female F-connector

Table 3: Parts List

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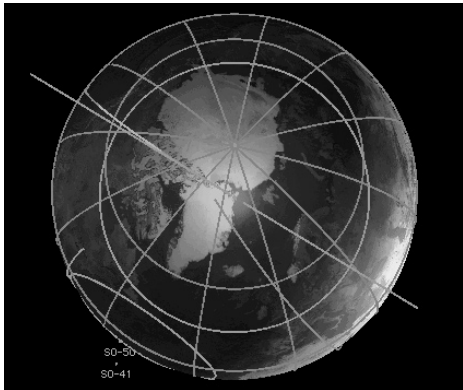
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The P3E project is a very exciting one that holds great promise for the return of AMSAT to the benefits of high earth orbit satellites. This project is being led by AMSAT-DL, as have all the HEO satellite projects. AMSAT in North America is contributing substantial manpower and funding to P3E and is committed to the success of the project and to our close relationship with our good friends and colleagues in AMSAT-DL. I am personally a member of AMSAT, AMSAT-DL and AMSAT-UK.

The Eagle project is maturing to the point that we will soon be ready to build the space frame and start assembling some of the payload modules like the Internal Housekeeping Unit and the U/V and L/S software defined transponders. Nearly all of the work that we are doing in support of P3E will also be used in Eagle so we will maximize the benefits of having cooperated on P3E. As with any new satellite design there are design issues and uncertainties. Let there be no mistake that these are normal and healthy parts of the design process as we balance the science, engineering, technology and mission requirements for Eagle. The Eagle team is large, diverse and excited about what they are doing. New qualified volunteers are being added to the team on a regular basis. Status reports are appearing in every issue of *The AMSAT Journal*.

This coming year will be one of improved communication. There will be an effort to expand our communications beyond the official outlets, the *Journal* and AMSAT News Service. You will see more reports on the AMSAT-BB message board and we will improve the content and timeliness of the information on the AMSAT Web site, especially on the Eagle pages.

AMSAT is an exciting and vibrant organization with a great deal to offer our members. No organization is perfect, but we have a fabulous Mission and Vision and we are performing to those promises. I encourage those who need more information or clarification to gain a better understanding

of what we are doing and why it is important and exciting to contact me or any of the other Board members and officers. Contact information is on the AMSAT Web site at <http://www.amsat.org/amsat-new/AboutAmsat/officers.php>.

Third Plenary Meeting of the Eagle Satellite Design Team

AMSAT-NA is hard at work on the Eagle satellite. This project is in direct support of AMSAT's strategic plan and vision statements that call for emphasis on building High Earth Orbit Satellites.

The third plenary meeting of the Eagle Satellite design team met on Friday, Saturday and Sunday, October 7-9, 2005.

As reported by VP Engineering, Bob McGwier, N4HY, there is significant progress on the P3E satellite's third generation Internal Housekeeping Unit (IHU3), the computer brain for P3E and later Eagle. There has also been progress on the new Software Defined Transponder (SDX) for modes U/V and L/S on Eagle. Lagging a bit, but still progressing, is the design of the C-C Rider C-band transponder for Eagle.

Refinements were made to the Requirements outline that had been published on the Eagle Web page in the document "2004 Summary now available online" and is already on line as "2005 Functional Requirements - Rev 1.0."

This meeting was the scene of many exciting new ideas such as a proposed new "Eagle Power System" by Lou McFaddin, W5DID, and the "CC-Rider Ground Station Proposal" by Mat Ettus, N2MJI.

There was far too much to report here, but watch for articles from the Eagle team describing the progress in every upcoming issue of the *Journal*. As Gould Smith, WA4SXM, said the day after the meeting "The project has excellent leadership, excellent technical expertise, a great deal of actual satellite experience and a wonderful 'get it done' attitude from all the teams."

Conclusion

I encourage you to contact your AMSAT leadership team directly with your questions and concerns. For best results, use the links and forms provided at: <http://www.amsat.org/amsat-new/AboutAmsat/officers.php>.

We need substantial financial support for the P3E and Eagle projects as well as the other fine programs underway in AMSAT. I encourage everyone to donate what they

can to AMSAT and, if possible, to become a sustaining contributor by joining the President's Club. You can do this by logging into the AMSAT store at www.amsat.org or by calling the AMSAT office directly at (301) 589-6062.

73,
Richard M. Hambly, W2GPS
AMSAT President ☸



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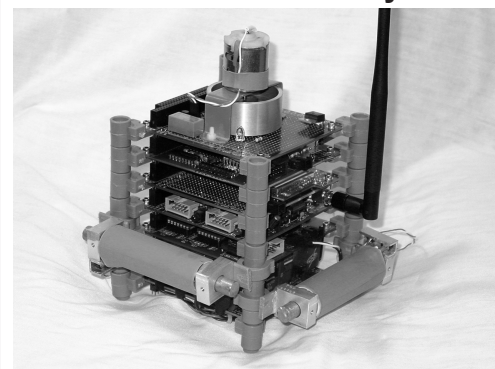
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The Linear-Up, FM-Down PSK31 Transponder

By Peter Martinez, G3PLX, peter.martinez@btinternet.com

Background

Some years ago on the PSK31 reflector, someone asked if anyone had ever worked PSK31 through a satellite. The discussion that followed concluded that it would be very difficult to handle the Doppler shift with a mode like PSK31, which is only 30Hz wide. That seemed to be the end of the topic, but I had other ideas.

I began to reflect on an idea originally proposed in the 1970's by Paul Dent, G3VEL. This was for a satellite with a 40kHz-wide linear uplink in, for example, the 2m band, with the signals down-converted to the audio range and modulated onto a UHF downlink using wideband FM. There were interesting advantages to this idea, which I shall describe in this article. This project never happened, but I realized more recently that it could be adapted for narrow-band operation.

In 2001, Bob, WB4APR, at the U.S. Naval Academy was discussing on the e-mail reflectors some ways to easily add some "wideband or multi-user" capability to his next PCSAT2 design that would require minimum additions to his existing FM uplinks and downlinks. I suggested the linear-up-FM-down idea using a 3kHz-wide audio band. The uplink receiver would then be conventional SSB and the downlink transmitter would be conventional NBFM, but the transponder would be shared by a large number of narrowband modes rather than used by single voice signals. Bob picked up the idea and asked for a volunteer to build the 10m linear receiver and began to incorporate the design into PCSAT2. Mirek Kasal, OK2AQK, at the Brno University volunteered to build the receiver. The spacecraft was complete in 2003 but Shuttle delays slipped the launch until July 2005 and now PCSAT2 is flying with this transponder. It's time to document this technique, set out the design requirements, and start to learn how this technique could be refined.

The Basic Idea

The essence of the idea is to notice that if we placed a UHF FM transmitter into a low earth orbit and modulated it with an audio tone then, although we would experience Doppler shift of the carrier, we would not see any Doppler shift on the audio tone itself. If we modulated the tone with

narrow band data such as PSK31, we could demodulate it on the ground with exactly the same methods that we use to receive PSK31 on the HF bands. We could modulate the FM carrier with a dozen PSK signals on different audio frequencies and copy them all separately and independently just as a 20m PSK31 operator does when setting an SSB receiver on 14070kHz and 'tuning' the PSK31 software over the audio range.

The trick then, is to put an SSB receiver up in orbit too. Of course, we *do* experience Doppler shift on the uplink, but if we choose a low frequency for the uplink and a high frequency for the downlink, we are only left with the smaller of the two shifts and not both, since there is no contribution from the higher frequency downlink. PCSAT2 uses a 29MHz uplink and a 435MHz downlink for this very reason.

But that's only a part of the beauty of this technique. Since each station listening to his own uplink signal on the downlink hears *only* the Doppler shift due to his uplink, if he were to correct his transmitter frequency so that there was no drift in the downlink, then *everyone else* listening to him on the downlink will also hear his signal with no drift. This is almost impossible to do on a linear-up/linear-down transponder because canceling the total Doppler shift on your own signal doesn't cancel the total Doppler shift for stations located in different directions

from the satellite.

It could be argued that it would be easier to leave the transmitter fixed and follow the drifting received signals. This is valid if we are only considering one transmitter, but if there are several uplink transmitters in different directions from the moving satellite, the Doppler drifts are different and we would have to be very careful with the frequency separation if we wish to avoid them drifting into each other. If we do this, it represents an extremely inefficient use of the transponder bandwidth. If we adopt uplink Doppler correction on a linear-up/FM-down transponder, this problem vanishes and we can stack uplink signals as close together as we like.

The AFC Problem and its Solution

To be able to compensate for drift, whether by making the receiver follow the signal or by controlling the uplink transmitter frequency, we need some kind of Automatic Frequency Correction system. Some kinds of signal could never be controlled by AFC. CW and SSB are no good because we lose the AFC during the gaps. FSK is not so good either because we can't completely separate frequency-shift data from frequency drift error without careful coding. Ideally we would like a signal which has a continuous and steady 'feature' from which we can extract the tuning offset, preferably independently of the information

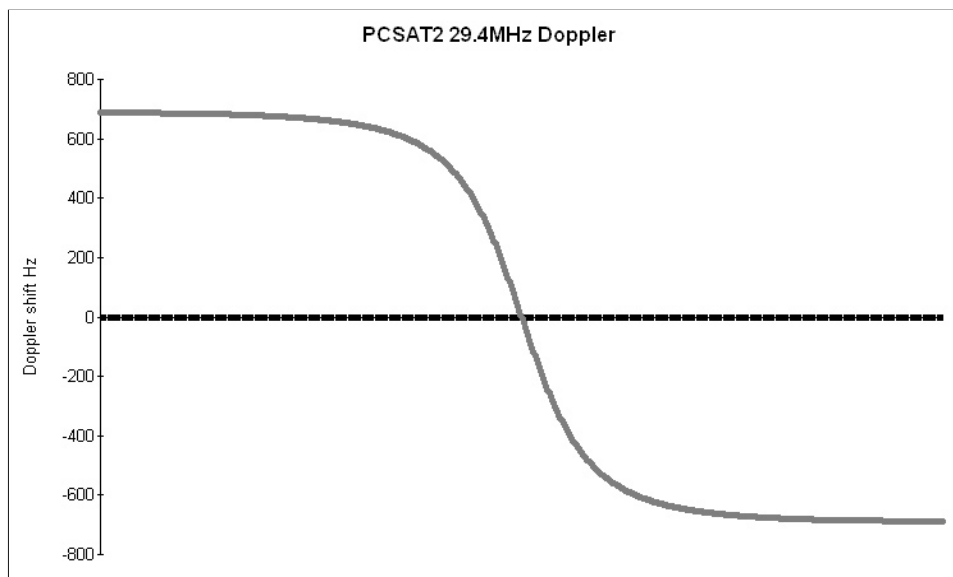


Figure 1: Doppler shift for PCSAT2 (on the ISS) on 29.4MHz during an overhead pass.

content. BPSK, as used by PACSAT at 1200 baud and by PSK31 at 31.25 baud, is ideal because there is always a signal there and the demodulator is able to extract both the data and the tuning offset independently of each other. BPSK is the only common digital modulation mode that has this property.

Figure 1 shows the Doppler shift experienced on the 29.4MHz uplink of the PCSAT2 transponder for an overhead pass. Can we correct this with an AFC system?

The traditional form of AFC takes the tuning offset value from the demodulator and applies a small fraction of this as a change to the local oscillator frequency. We don't remove the offset completely in case it was due to transient noise or loss of signal. The result is an AFC system which will remove any initial tuning error completely, given time to settle down. For example, a BPSK demodulator, designed to give stream of binary data at the rate of 31.25 bits/sec, can also give, as a byproduct, a stream of analogue 'tuning offset' values in the range $\pm 7.8125\text{Hz}$, at the same rate. If we subtract, for example, $1/100^{\text{th}}$ of the tuning offset from the receiver frequency each time we demodulate a symbol, the tuning error will eventually be reduced to zero in an exponential decay, and the time-constant of this decay is approximately $100/31.25$ seconds. This gives the AFC loop in this example a 3.2 second time-constant, a good compromise between the need to follow a drifting signal and staying locked through a short disturbance. So long as we force the receiver in-tune initially, this kind of AFC

system will always stay on tune, regardless of how far the signal drifts.

However, this simple AFC loop has a major drawback if we want to handle a signal that is drifting at a high rate. Consider what would happen if the signal was drifting at 1.25Hz/sec . To be able to follow this drift, the receiver frequency needs to change by $1.25/31.25\text{Hz}$, or 0.04Hz at each received symbol. Since this change is derived from $1/100^{\text{th}}$ of the tuning offset for each symbol, it means that this offset must have to be $100 \times 0.04 = 4\text{Hz}$. Turning this around, it means that a 1.25Hz/sec drift rate can only be handled if there is a residual tuning offset of 4Hz . Considering that the PSK31 system can only handle $\pm 7.8\text{Hz}$ without error, this means that 1.25Hz/sec is probably about as fast a drift as we could tolerate. This is nowhere near enough to handle, for example, the maximum Doppler rate experienced on PCSAT2 on 29MHz (14Hz/sec for an overhead pass). Figure 2 shows the Doppler rate calculated for an overhead pass of the PCSAT2 uplink. If we try to increase the amount of feedback, we run into problems with the AFC throwing the receiver off on bursts of noise or periods of fading. We need something a lot better than this.

The solution I have used successfully on PCSAT2 is what I call a second-order AFC system. This idea comes straight from control system theory, so it's not new. Instead of using the tuning offset to adjust the receiver frequency, it adjusts the receiver frequency *sweep rate*. The greater the tuning offset, the *faster* the receiver sweeps up the

band to reduce the error. In the case of the above example of a drift rate of 1.25Hz/sec , this system, when it settles down, will end up with the correcting sweep rate exactly equal to the signal drift rate, and with zero residual tuning offset.

There are, however, two snags. The first one sounds at first like a fatal flaw. I said above 'when it settles down', but if you build such an AFC system or simulate it on a computer, *it never settles down* but continuously oscillates around the centre. Again, control system theory comes to the rescue. We introduce a 'damping factor' into the system, analogous to the shock absorbers on the suspension system in your car. In the case of the AFC process, the damping is achieved with an extra component added to the feedback, adding a change to the frequency proportional to the tuning offset. In other words, having *both* the second order correction *and* the original conventional AFC feedback applied at the same time. In this case we choose the amount of 'first order' feedback to give the whole AFC loop the required level of damping. It will always overshoot, but by adjusting the amount of damping, we can set this to minimize the period of oscillation while still being immune to noise. Exactly like a suspension system in fact.

The other snag is equivalent to the residual tuning offset we experienced with the first order system when subject to a constant drift rate. In this case we get a residual tuning offset when the system is subject to a constant *rate of change* of drift rate. Figure 3 shows the rate of change of Doppler drift rate on the overhead PCSAT2 pass and shows that the worst-case values are $\pm 0.24\text{Hz/sec/sec}$ and occur at two points in the pass, about 25 seconds before and after the point of nearest approach. If we want to make sure that the maximum residual tuning offset is, for example, 4Hz at these two critical points in the overhead pass, then we need to set the amount of second-order correction so that a 4Hz tuning offset gives a rate-of change of 0.24Hz/sec/sec , then adjust the damping factor to give an acceptable dynamic response.

The subject of damping second-order control systems is beyond the scope of this article, but in practical terms, it works out that if we start from a first-order system and add the second-order term that would be required to handle the expected Doppler shifts, the damping comes out about right,

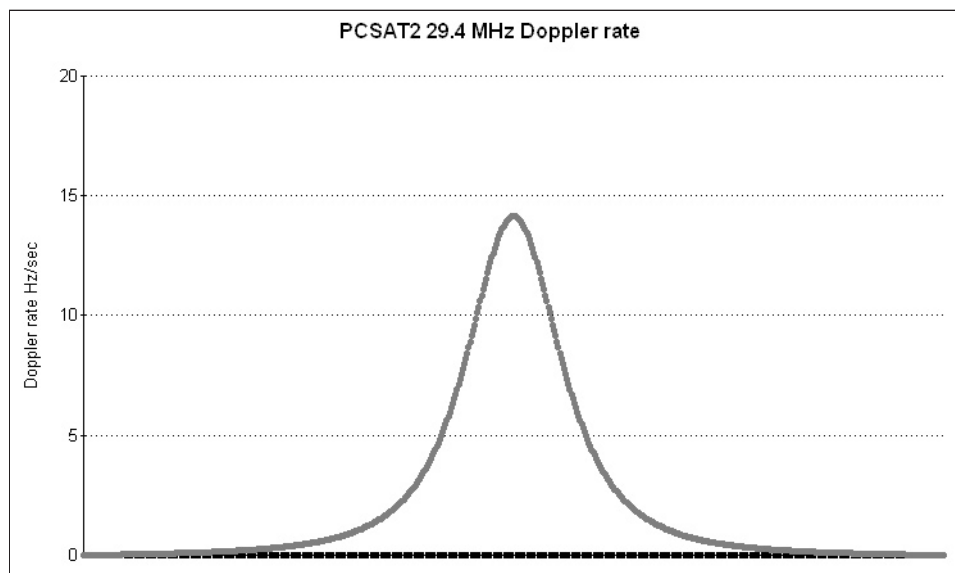


Figure 2: Rate-of-change of the Doppler shift calculated from the graph of Figure 1.



and there's plenty of scope for handling other orbit characteristics.

To illustrate graphically the end result of applying this kind of AFC to the uplink transmitter, Figure 4 shows a waterfall display of a 1600Hz segment of the downlink band of PCSAT2 centered on 1000Hz, as received at DK3WN during the first tests with the transponder. It shows G3PLX with uplink Doppler correction locked to 1000Hz, and DK3WN transmitting with no Doppler correction (but some manual adjustment!). This is for a pass with a maximum elevation of 45 degrees. At the bottom of the downlink band is an unknown station evidently using a Doppler prediction system to correct his uplink frequency in steps, but the step-size is too large and this results in a sawtooth frequency error pattern. The two constant horizontal lines at 380 and 560Hz are probably birdies in the satellite receiver. At the start of this trace G3PLX is not receiving the downlink and doesn't achieve lock until just before 'G3PLX' is shown in red, but you can see that successive adjustment steps reduce the sweep rate error until lock is achieved.

There are two more things to note before leaving the topic of second-order AFC. The first is the process of locking to the signal in the first place. Figures 1 and 2 show that when the satellite first appears over the horizon, the Doppler rate is zero, so if we tune to the signal at that time the loop will surely lock and accurately track the signal for the rest of the pass. But if we don't hear the signal immediately and the Doppler rate is significant, we may not be able to

lock because the AFC has not followed the increasing sweep rate. We need some way to manually set the sweep rate close enough to the actual Doppler rate if we wish to lock to a signal which is already sweeping rapidly down the band. There are several ways to solve this. For the 29MHz PCSAT2 situation, where the task is to find a chosen signal (mine) from those displayed in a spectrum, my solution has been to make the arrow-keys that I normally used to position a cursor over the signal I want, so that they not only make small steps in the frequency but also make small steps in the sweep rate. The more I step the frequency towards the correct tuning point, the more I am also stepping towards the correct Doppler rate. When I eventually catch the signal, there will be a small overshoot, but the end result is to get the signal on-tune at the correct rate. It's more like the process of 'steering towards' the correct spot than 'positioning on' it, but it's quite instinctive and certainly easier than trying to position the signal with one control and simultaneously adjust the sweep rate with another.

The second point to note is that we are limiting ourselves to the use of SSB transmitters for the uplink, and correcting the uplink Doppler shift by sliding the frequency of a narrowband emission such as PSK31 up the audio band using a software process. We will therefore be limited to satellite links for which the peak-to-peak Doppler shift is less than the bandwidth of the SSB transmitter. We are probably therefore restricted to an upper limit of 30MHz for the uplink of low earth orbit satellites.

Uplink Power Control

Another interesting feature of an FM downlink is that the received audio level is completely independent of downlink signal level, unlike the linear/linear transponder where both uplink and downlink fading effects are present in the received downlink. This reduction in fading is particularly relevant to permit narrow-band to work. The FM technique means that we can use UHF or even microwave frequencies for downlinking signals as narrow as PSK31. This would not be possible with a linear UHF downlink, even with Doppler correction.

The constant audio level of an FM downlink also gives another interesting technique to explore. If we have a fixed gain in the satellite uplink receiver, and each uplink station monitors the level of his own signal returned in the downlink audio band, it will be possible for him to adjust his uplink power level to keep the downlink audio level constant. This could form the basis of a very effective way to ensure that all uplink signals share the transponder equally. Like the uplink Doppler correction process, this is another feature of the linear-up/FM-down transponder which is almost impossible to achieve on a linear/linear transponder. The 29MHz uplink receiver in PCSAT2 is fixed gain (although an AGC line is present to prevent over deviation of the downlink), and I have implemented such a control system in soundcard-based software to work through PCSAT2. The amplitude of my own received downlink signal is compared with a target value, and the difference drives the amplitude of the transmit signal up or down at a proportional rate. I chose the rate constant to give the overall loop a time constant of a few seconds, to ensure that the control process does not interfere with the modulation. The control loop works extremely well, typically turning the power down from 50 watts to 2-3 watts during a near-overhead pass. Note that the 'target value' mentioned above is a downlink deviation figure. When implementing such a system, it will be necessary to calibrate the FM downlink receiver and soundcard so that the software adjusts to the required deviation.

However, I foresee problems with widespread use of this technique. Imagine a transponder designed to fully modulate the downlink with, say, 10 uplink stations operating, and imagine a small disturbance which just causes the transponder to overload slightly

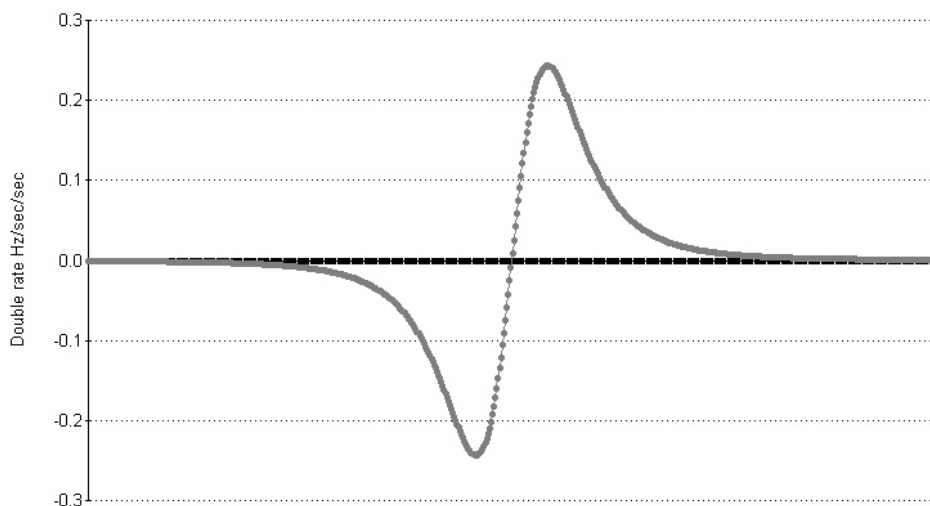


Figure 3: Rate-of-change of the graph of Figure 2, showing the double-rate-of-change of Doppler shift.

and protect itself by reducing its receiver gain. Each uplink station sees a drop in their own downlink signal and compensates by increasing power. This makes the overload rapidly worse and ends up with all uplink stations at maximum power and the transponder well into AGC. The only way to recover from this 'lock-up' state is to get all uplink stations to switch off and bring their power levels up again, very carefully.

This arrangement would be quite unworkable in the Amateur Radio environment. We clearly have no way to prevent an 11th uplink station from trying to work through a fully-loaded transponder designed for 10 signals. The transponder must overload gracefully or we must devise a power-control process that doesn't lock up.

An uplink power control scheme based on downlink level cannot do this. There are other reasons why it's not a good idea. The more signals we allow, the higher the downlink CNR needs to be to copy *any* of them, even if, at any given time, there are a smaller number of stations working through. It would make better sense to share the full downlink deviation between however-many stations were working through the transponder at the time, rather than allocating a fixed level to each station based on the design equations. This way, we could either transmit a small number of signals to a number of low-spec. downlink receivers (e.g. broadcasting), or use higher

performance downlink antennas when we want to fully load the transponder. There's another problem with the fixed-gain, fixed-level scheme. If we suppose we might want to use different types of signal through the transponder at different times. This arises because we need to set the receiver gain to match the bandwidth of the signal and the SNR we need to receive it. For example, if we set the receiver gain too high, we may not be able to get enough uplink SNR to support a wider bandwidth mode, and if we set it too low, we would need to transmit more power with narrower bandwidth modes to fully modulate the downlink. It would be much better if we didn't have to make the gain choice before we launched the satellite and be tied to that value.

All these problems mean that, although the FM downlink does make a simple end-to-end level-control system possible, it really isn't a good idea. We have to do it in a different way. We can make the transponder handle a small or large number of signals, of a wide range of bandwidths and SNR levels, simply by giving it enough gain that it *always* runs into AGC. This means that even the uplink receiver noise will fully-modulate the downlink. There is no reason to keep this noise 'in the background' as we would for a linear downlink or a receiver in the shack. Running the satellite receiver fully AGC-controlled also makes it much easier to design, when we consider things like

temperature variations.

Having thrown away the downlink level variation, how do we now control the uplink power? Imagine there is no one transmitting through such a transponder and station A wants to work through. The downlink is 100% noise. He simply increases power until his downlink signal comes out of the noise and gets to the SNR he needs to copy himself. Station B appears and adjusts his uplink until it's the same level as that of station A. If A and B both have good downlink CNR so that the uplink noise dominates in their received downlink audio, they will both experience the same SNR and will copy themselves and each other. Note that A didn't need to touch his uplink power when B started transmitting, even though the transponder gain dropped, because the noise level dropped too. Things only go wrong when there are so many stations sharing that some of them can't copy because all signals get lost in their downlink noise.

I have described this process as if it was done by the operators watching the downlink signals and adjusting their transmitter powers, and indeed it's simple and intuitive enough to be done that way. The two rules are (1.) don't make your own signal stronger than it needs to be and (2.) don't make your signal stronger than anyone else. Of course, if one station does transmit too much power, everyone else will increase power to compensate and the lowest power

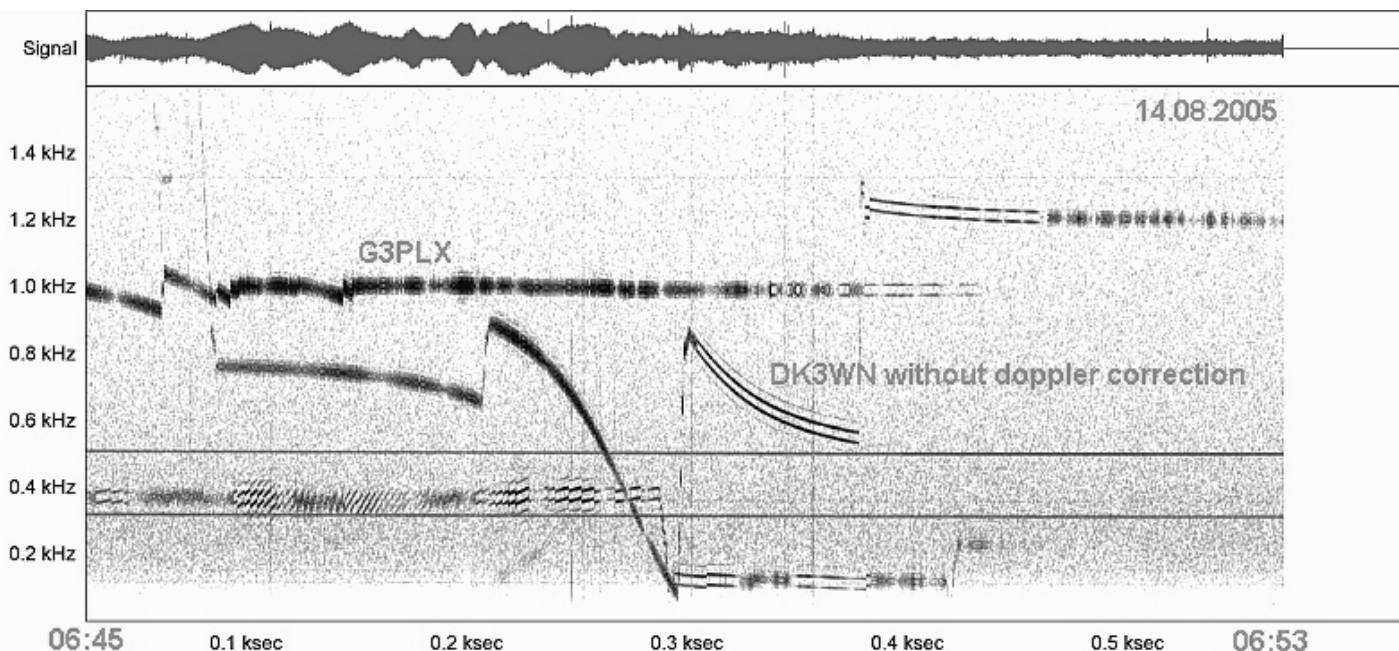


Figure 4: Spectrum analyzer "waterfall" display showing 1600Hz-wide segment of the PCSAT2 FM downlink audio with Doppler-corrected and uncorrected 29MHz uplink signals.



stations still lose out, just as they would with any linear uplink. But since everyone can hear everyone else in the 3kHz downlink audio, there are none of the problems that can plague a wider bandwidth linear uplink because the power-hog cannot hear what effect his signal has on everyone else up the band. All stations can see the whole picture and can learn to share the facility. If we also emphasize the self-evident rule that you *don't* transmit if you cannot copy downlink signals, then there is an inherently stable mechanism for limiting the total transponder load, because it will get progressively more difficult to copy signals as their number increases.

It's clear that we have all the information we need in the downlink audio to automate the uplink power-sharing process if we choose to go that route. Losing the level feedback by having AGC in the transponder does not lose us the ability to control the uplink population. The software (on the ground) needs only to measure the relative levels of the various signals and the noise. Any PC with a soundcard can do it. There will be no need to calibrate receiver levels against downlink deviation. There is no nasty lock-up effect.

To summarize the power control topic, although a simple level-based control loop is very easy with a linear/FM transponder, it's much better to run the transponder 'flat-out with AGC' and solve the sharing problem with a level-comparison method driven by the user or by a process running in his computer.

Transponder Carrier Control

With a single-user 'repeater' transponder, the downlink transmitter is always switched off when not being used, to save valuable solar energy. With a linear/linear transponder, the downlink transmitter is on all the time, but at least it only takes a small amount of idle power if it's not being used and the energy consumed only rises when someone is working through it. With a linear/FM transponder, unless we do something about it, the carrier will be running at full power all the time and this could be undesirable. On PCSAT2, the linear/FM transponder is turned on by command from the ground when needed. This is fine for an experimental set-up but is too costly in manpower to be an operational solution. It really would be nice to have a way for the transponder to sense when it is needed entirely from its own uplink signal. For the specific case

of a linear/FM transponder intended for PSK31 use, I propose a method which uses a particular characteristic of a PSK signal which is ideal for the purpose.

If we listen on an AM receiver to a section of a band in which PSK31 activity is taking place and look at the spectrum of the demodulated audio, we will find that there is always a 31.25Hz component present. This amplitude modulation is a byproduct of the process of switching from one phase to another and is present with all types of PSK and always gives a pure tone at the baud rate. This feature is used in the PSK31 receiver to synchronize the decoder. If we installed an AM detector in the satellite receiver, followed by a 31.25Hz tone detector, very like the continuous sub-audible tone detectors used on FM systems, we will have a reliable way to detect the presence of one or more PSK31 signals anywhere in the pass band. The absence of such a tone can be used to signal the control system to shut down the transmitter. From the theoretical standpoint, a square-law detector would be the best for this job, although it's not critical and an approximation to square-law would be sufficient. This same characteristic is exactly what is needed for the AGC detector, so the same bit of hardware would do both jobs. With the receiver AGC-limited all the time, the AM signal to the tone detector would be constant level, making the detection mechanism inherently immune to variations in gain and noise levels. It would also be immune to false-triggering by most other types of signal.

The Pre-emphasis Puzzle

It's traditional with FM voice transmitters to add pre-emphasis to the transmit audio. That is, to boost the higher frequencies at a rate of 6dB/octave over the entire 300-3000Hz range. A complementary de-emphasis is used in the traditional FM receiver. This is done because of a well-understood effect in noisy FM radio links where the background noise in the demodulated audio rises in level at the higher frequencies. The pre-emphasis/de-emphasis technique counteracts this reducing the high-frequency noise in the speaker and resulting in the SNR being constant over the audio spectrum. Boosting the HF frequencies doesn't cause over modulation (or require us to back off the drive to prevent it), because the human voice has very little high frequency energy.

It's useful to consider whether pre-emphasis is appropriate for the FM downlink of a

linear/FM transponder intended for multiple narrow-band signals. Without it, if the downlink is noisy, those signals at the top end of the audio band will suffer more noise than those lower down. De-emphasis in the receiver would flatten out the background noise spectrum, but pre-emphasis at the transmitter would risk over modulation by signals at the top end of the audio band - a 3 kHz band full of PSK31 signals is not predominantly low-pitched like a voice. There's a difficult decision to make here: would it be best to share the transmitter modulation equally between signals in all parts of the transmitted audio band, or should we share the SNR equally between signals in all parts of the receiver band? We can't do both in an FM system.

The downlink FM audio on PCSAT2 was designed before the pre-emphasis question was considered, and does not utilize pre-emphasis. Therefore, I have used for my tests with the PCSAT2 transponder, a receiver with a flat response (no de-emphasis) and have watched the downlink noise spectrum carefully. I have not seen any sign of an upward tilt in the background noise. The reason for this is not fully understood. One possibility considered was that the uplink receiver noise always dominates. It was possible to check this by muting the PCSAT2 uplink receiver output briefly under control from the ground using a fortunate side-effect of switching the command link to a back-up configuration. The received downlink noise level did not drop when this was done, so it does seem that the downlink audio noise spectrum really is flat and there is no SNR penalty at the HF end. This is contrary to theory, and needs to be more closely studied. It may be that the 'tilted noise spectrum' theory does not hold at the low carrier SNR levels seen on the PCSAT2 down link in the tests so far. That is, it may be that the spectrum of the 'rough' noise that is present on a weak FM signal is flat, and only the 'smooth' noise of a stronger FM signal is tilted. I have seen, on tests with PSK31 modulating terrestrial FM links that it is possible to copy such signals at much lower signal levels than it would be possible to copy voice, so it may be that the PCSAT2 downlink signals seen so far have never been strong enough to be in the 'smooth noise' region. If this can be satisfactorily explained, then we can forget about pre-emphasis in the downlink transmitter.

However, if we do choose not to add pre-



emphasis to the FM downlink, we still need to remember that most FM receivers have de-emphasis as standard. Some FM radios do have a 'flat response' audio output (often provided for 9600 baud packet use), and this would be the best way to pick off the signal to go to the soundcard and the software. But if no such auxiliary output is available, steps should be taken to remove the effects of the de-emphasis, which is built into the receiver. This is particularly important when considering the requirements for uplink power-sharing.

Conclusions

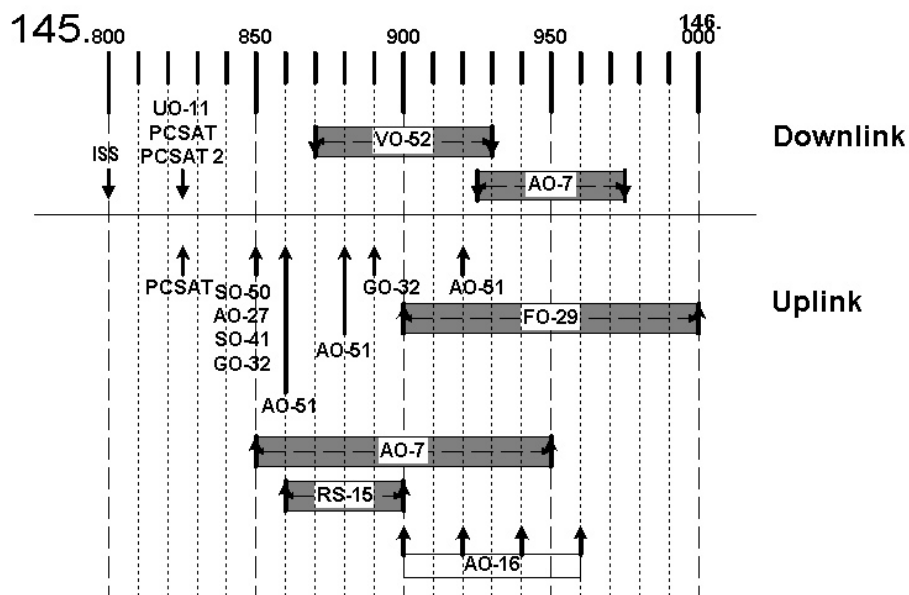
I have shown that the linear/FM satellite transponder concept not only eliminates downlink Doppler drift, but can be used to eliminate Doppler drift completely to the extent that even the narrowest bandwidth modulation methods can now be considered viable for low-earth orbit satellites using UHF or SHF downlinks. When used with PSK31 on uplinks below 30MHz, Doppler and power control processes can be implemented entirely with soundcard-based PC software on the ground, in conjunction with standard HF SSB transmitters and UHF FM receivers. I have described an extension to the traditional AFC mechanism which can handle the Doppler shifts and Doppler rates on low earth orbits for uplinks below 30MHz. I have highlighted an overload problem with simple uplink power control schemes and suggested a way forward for future linear/FM transponder designs which eliminates this and other drawbacks of the simple level-control scheme. I have suggested a novel CTCSS-like method for downlink power economy. I have further discussed the implications of the use of pre-emphasis on transponders of this type. I conclude that future transponders of this type should have full AGC action to give constant downlink modulation level, that no pre-emphasis should be applied to the downlink transmitter and that detection of the 31.25Hz modulation of uplink PSK31 signals may be a useful way to 'squellch' such a transponder.

I would like to thank Bob Bruninga, WB4APR, and Miroslav Kasal, OK2AQK, for their help in the preparation of this paper, and Mike Rupprecht, DK3WN, for Figure 4.

Transponder Frequencies by Gould Smith, WA4SXM, wa4sxm@amsat.org

Amateur Satellite Frequency Usage

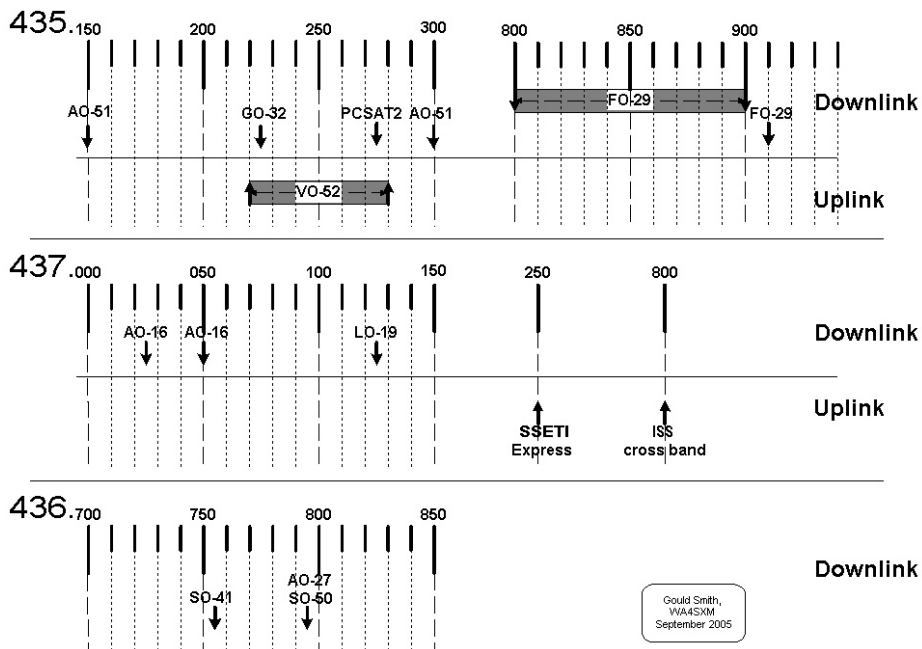
allocation is 144.3 - 144.5 & 145.8 - 146.0 MHz



Gould Smith,
WA4SXM
September 2005

Amateur Satellite Frequency Usage

allocation is 435.000 - 438.000 MHz



Gould Smith,
WA4SXM
September 2005



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by Mal Preston, NP2L

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W2KJ
W2KQ
W2PB
W2UDT
W2XB
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K3MS
KA3HSW
KB3CWQ
KB3CYW
KB3DXR
KB3GI
KB3LDM
KC3AN
N3BXL
N3CRT
N3HMW
N3LSY
N3OY
N3RZN
NX3B
W3BPB
W3BW
W3EVE
W3HYM
W3QBC
W3STW
W3TFA
W3UJG
W3XO
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WA3GOV
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AA4RC
AG4DJ
K4DSD
K4KSIJ
K4PRK
K4UAS
KB4ABE
KB4YML
KC4ASF
KC4RIC
KD4CNS
KE4RFT

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BILL SCHMITT
THOMAS LEWIS

KF4BWQ
KF4CUP
KF4OOV
KF4OTN
KG4YJR
KI4FBF
KI4YV
KJ4SO
KU4OS
N4GMT
N4OE
N4QWF
N4TSV
N4ZPT
NF4A
W4AKE
W4DXV
W4EAT
W4EPI
W4JKL
W4LNA
W4MVB
W4OWA
W4PZA
W4RI
W4SM
WA4FXX
WA4GWG
WA4SIR
WA4SWJ
WA4VZW
WA4WDL
WA4YVZ
WB4APR
WB4GCS
WB4ZMP

5th Call Region

AA5F
AC5E
AD5PO
K5DXX
K5LXP
K5MAN
K5TEC
K5VRF
KB5MU
KB5VHG
KD5DAY
KE5EJD
KF5B
KI5AB
KK5DO
KK5MV
N5IST
N5JXO
N5RMJ
N5UXT
N5VHO
W5ACM
W5RPS
W5SSG
W5ZA
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AA6RR
AB6UI
K6ELQ
K6QB
K6QXB
K6UX
KC6TWS
KC6WGQ
KD6MTU
KD6PPM
KE6HFW
KE6VOS
KF6WND
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WA6CFM
WA6ICW
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7th Call Region

AA7MH
AA7RV
AC7ZR
AE7AA
AI7W
AL7HF
AL7LN
AL7OB
K7JW
K7OPA
K7VK
KC7DBA
KC7JRU
KC7VX
KD7OTV
KD7TSK
KK7P
KL7UW
KU7Z
N7BRJ
N7BRJ
N7OLS
NE7X
W7AI
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K8CJ
K8DID
K8MMO
K8MU
K8RQ
K8VEB
K8XG
K8ZK
K8ZZU
KB8DXJ
KC8NSA
KC8OUJ
KD8WV
KE8RG
KI8G
N8ANR
N8AVR
N8BBQ
N8BMA
N8FGV
N8GZL
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W8KSW
W8XF
WA8YCD
WB8NUT
WB8OUE
WB8SBI
WB8UYA
WB8VBG
WD8NNG
WN8D

9th Call Region

AA9DY
AA9GY
AJ9N
K9ATR
K9EK
K9JDK
K9KK
K9QKW
K9SM
K9UTQ
KA9ETP
KA9VGG
KB9WEK
KE9V
N9LYA
W9CBS
W9GX
W9JU
W9NET
W9VEQ
WA9AFM/5
WA9BST
WA9PYH
WB9CKN
WB9CNS
WD9EWK
WI9WI JIM

10th Call Region

AF0SS
K0AIZ
K0CY
K0RGR
K0SBH
K0USQ
K0UT
K0VPL
KA0IQT
KA0OJH
KA0SWQ
KC0ERG
NOIGD
NOIVN
NOMKJ
NONHJ
N0NSV
N0PFF
N0VSE
N0YKX
NB0Z
W0ENB
W0PEC
W0SL
WB0FTL
WB0JBH
WB0SOK
WB0VGI
WD0EQP
K1DM

Canada

VA3DB
VA3KKZ
VA3LNS
VE1AMA
VE3EDR
VE3EMA
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GM0ICF
HB9MAD
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2006 AO-51 Kids Day Events

by Mike Kingery, ke4azn@amsat.org

Kids Day on AO-51 in 2006 will be held on the same dates as the ARRL event. The dates will be January 8, 2006, and June 17, 2006. To continue the success of our first year's Kids Day on AO-51, we are announcing the dates well in advance to allow everyone a chance to make their plans and participate in the event. This would be a good opportunity for a club or organization to have a special event planned around educating children in Amateur Radio satellite activities. Please watch the amsat-bb and the AMSAT ANS bulletins for specific information on the mode of operation for AO-51 near the event date. See <http://www.arrl.org/FandES/ead/kd-rules.html> on the ARRL Web site for more Kids Day information.

See certificate below for Kids Day 2005.



AO-51 Kids Day Award June 2005

*The Control Team for the Amsat AO-51 Amateur Radio Satellite,
known as Amsat-ECHO, is proud to congratulate*

Ben Swart - VK2TRF

*for successfully completing an amateur radio contact via the Low Earth
Orbiting Satellite AO-51 during the June 2005 Amsat Kids Day Event.*

AO-51 Control Team

Mike Kingery - KE4AZN
 Jim White - WD0E

AO-51 Operations Group

Mike Kingery - KE4AZN
 Drew Glasbrenner - KO4MA
 Clare Fowler - VE3NPC
 Roy Welch - W0SL

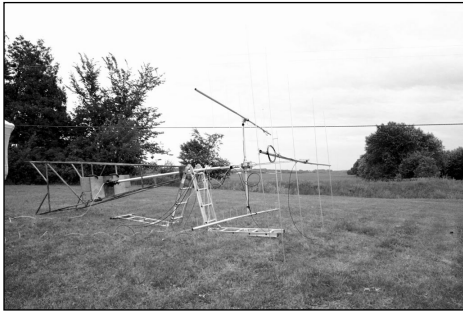
Michael Kingery - KE4AZN
Amsat-NA VP Operations



A Field Day Experience

by John P. Toscano, W0JT, tosca005@tc.umn.edu

Well, the 2005 Field Day exercise has come and gone. I participated with the Twin Cities Repeater Club (TCRC) from Burnsville, MN (Twin Cities refers to Minneapolis and St. Paul, for those of you who don't know much about Minnesota geography). We were operating as W0BU, 3A, MN, with a GOTA station and a VHF/UHF/satellite station of which I was in charge of again this year. It was a whole lot of fun, and I thought I'd share a few thoughts on how we made it fun.



1) Plan, plan and plan some more. Then check your plans, fix the mistakes and plan some more. OK, Field Day is, in some respects, supposed to mimic the spontaneous erection of an emergency communications network with no prior warning after a disaster strikes. But that doesn't mean that advance planning is not appropriate. For example, shortly after Field Day a few years ago, a series of tornadoes passed through the town of Comfrey, MN, south of the Twin Cities metropolitan area and quite a few hams from our area drove down there and applied what they had learned from their participation in Field Day to set up a highly effective communications center to relay emergency traffic from the disaster site to the metro area where most of the assistance was coming from. All of the traditional communications in Comfrey were knocked out for several

days except for what the hams provided. So, even though it is a bit "artificial" to plan in advance because disasters usually have little warning, it is still appropriate to go through the exercise with a lot of thought, so if/when the real thing happens, you will actually know what to do and how to do it! Besides, have you ever had a fire drill at your place of work or school? They didn't have to set the building on fire first to make it a useful exercise!

2) KISS (Keep It Simple, Stupid!). Don't overextend your plans to an exorbitant degree. Simplify. Concentrate on the essentials. Plan to do something manageable rather than attempting the impossible and finding out that, indeed, it WAS impossible. Sure, challenging yourself to do a little more or a little better than last year can be an exercise in personal growth, but that's a far cry from setting yourself up for certain failure, which seldom causes much personal growth.

3) Be as prepared as you reasonably can, but don't lose sight of the concept that Field Day is all about operating under less than optimal conditions. In other words, don't expect perfection, be prepared to compromise and be prepared to improvise.

4) Decide on your goals, and design your plans accordingly. If you are a hard-core contester and the only thing you care about is running up the highest score possible, then arrange for as few distractions as possible, get the best operators possible, and keep out the newbies and the currently unlicensed wannabees. You don't have time to teach them, or answer their questions, or build their interest. If, on the other hand, you want Field Day to be a preparedness exercise that is also the premier social event of the year for your radio club with an emphasis on

getting inactive folks on the air and attracting newcomers, and educating existing hams to move beyond their present operational horizons, then you must be prepared to accept a lower score. In case you haven't guessed, our approach in TCRC is the latter, not the former, though we still manage to post a respectable score each year.

Ok, so that's a lot of generality. What did we do specifically to follow those ideals?



In the planning stage, I first reviewed what had been done in the past. I was licensed in late 1996, so my first opportunity to participate in Field Day was June 1997. However, because there hadn't been enough pre-event chatter in the club, I was totally oblivious to the upcoming event, and scheduled an out-of-town family vacation that included that weekend. Oops. Ever since 1998, I not only have participated, I have also been selected to be the manager of one of the stations. In 2003 and 2004, I managed the 20 meter phone station, but in all the other years, I was in charge of the VHF/UHF/Satellite station.

My first year, 1998, I got my first taste of satellite operation as I watched N0BEL knock out a few satellite contacts on his Icom 820. I was bitten by the satellite bug then and there. It wasn't long before I started accumulating better home station gear, including a Yaesu FT-847. In any case,





in the years from 1998 to 2004, the VHF station ranged from as little as a 6M, 2M and 70cm station in which no one bothered to try satellite ops (and in one year, almost no one spent any time operating the station at all), to a station with all bands from 50 to 1296 MHz plus 10 GHz.

I learned several lessons that year: (a) the incredible amount of work it was for me to haul out basically everything except a tower, generator and shelter for such a complex station, set it up, operate it, tear it down and bring it home; (b) how easy it is to break a mast in half if it is too long, and has too many antennas on it; and (c) what it feels like to see over a thousand dollars' worth of high-end antennas accelerate towards the ground. So, my first decision was to concentrate on 6M, 2M and 70cm for terrestrial operations, and consider adding an L-band uplink and an S-band downlink for satellite ops.

Looking over the wonderful amsat.org Web page on satellite status (thanks a million, Emily!), it occurred to me that no voice satellites would be using L band uplinks on the Field Day weekend, and the only one operating on S band down was AO-51, in FM mode. Hmmm, considering what a mess FM satellite operations would be during the frantic feeding frenzy of Field Day, if I decided to forego FM mode, I could also drop L and S bands with no extra penalty. That means 3 antennas instead of 5, one radio instead of a radio plus a receive converter plus a transmit converter, a simpler antenna array support structure, etc. Very appealing.

So I promptly decided that would be my plan; concentrate on AO-7, FO-29 and VO-52 and forget the rest. Don't get me

wrong, I am proud to say that my credit card and I supported the "Give Echo a Boost" program, but I just didn't want to fight for a slot in a one-channel FM bird on Field Day. The next thing that crossed my mind as I reviewed the prior years' satellite ops was that we had never had antenna elevation capability. So we were restricted to satellite passes close to the horizon and we always had a lot of interference between our uplink and downlink on the 2M and 70cm bands because the antennas were stacked above one another, much closer than they should have been, especially after the fiasco with the broken mast! The satellite QSO's were a struggle and we seldom got more than a couple. This year, I decided that I would bring out the elevation rotor, mount the 2M and 70cm antennas on a 6-foot long wooden cross-boom side-by-side, and mount that assembly far enough below the 6M antenna that I could elevate them without mechanical interference. Since the antennas radiate much less signal at 90 degrees away from where they are pointed, having them side-by-side and 6 feet apart was much better than having one over the other, and only 1-2 feet apart.

This is where the planning really paid off. I gathered up all the bits and pieces of the antennas and support structures and started laying them out on my lawn. I quickly realized that I had underestimated (forgotten) the length of the 2M-12 and 432-9WL antennas that I was going to use. I thought that they were "only" 18 feet long, so that a 9 foot separation between the elevation rotor and the top of the mast would be enough to keep them from hitting the 6M-5X antenna at the top. WRONG! They are more like 20 and 21 feet long and I didn't have enough mast

to make that work. If Mike Stahl from M-Squared is reading this, I can only apologize in advance to him for how I dealt with this. Mike, I took your beautifully engineered, highly optimized antennas and removed the front couple of boom sections from them to shorten them up so they would fit! I know it's a crime. But if it's any consolation, all I can say is that you guys designed such superb antennas (in their full length) that they still gave more than adequate performance after my temporary butchering of them. Besides, I promise to put them back together properly before I install them on my home tower.

More planning: satellite passes. In the past, I had used either Predict or STS-Plus for real-time tracking on my old Pentium laptop running Windows 95. That laptop is history. My current laptop is a Pentium III running Windows 2000 and I could not get either program to run on it Ouch! Though I haven't given up on them yet I didn't have time to figure out the solution to the problems by Field Day.



Fortunately, my Palm Tungsten C came to the rescue courtesy of Jim Berry's PocketSat+ program. This software ran annoyingly slowly on my old Palm IIIc, but on the Tungsten C it cranks through the calculations in the blink of an eye and is a pleasure to use. I pointed it in the general direction of the 802.11b wireless access point in my home network, used the built-in Web browser to download keys from amsat.org (thanks again to Emily, Paul or whomever arranged for the keys to be available in PDF format ready-to-go) and I was in business. I ran pass predictions for the three linear birds of interest to me, starting a few days before Field Day (in case I had time for some practice runs) and running to the end of the Field Day period. I set alarms so that the Palm device, even if turned "off", would "wake up" and warn me every time a pass was about to begin. What a blessing to have! I could now bang away on the





VHF/UHF station in terrestrial mode all I wanted and when a good pass was about to start, I could decide if it would be better to keep going, such as when the 6M sporadic E event was underway, or to switch over to satellite mode for a while when the VHF and UHF bands were “dead”. And I could still get real-time tracking with continuously-updated azimuth and elevation information during each pass.

More planning in keeping with KISS: Not only did I limit myself to one radio, the FT-847, and no transverters, I also decided to leave the amplifiers at home. I certainly didn’t need 150 watts on 2M or 100 watts on 70cm for satellite work and if the terrestrial stations couldn’t hear me at the barefoot 50 watts of the FT-847 on those two bands, would they really hear me much better with less than one S-unit of additional power? Not only could I bring less gear I also automatically avoided the problem of an operator unfamiliar with my equipment accidentally over-driving the amps and blowing them up. I bought the amps used from an estate sale of a Silent Key and while they give me very good service, they aren’t the best match to my radio.

The 2M amp wants only 10 watts of drive for full output and the 70cm amp wants only 30 watts of drive for full output. I think you can guess what happens if the power level was turned up to 100% for operation on 6M at 100 watts and you forget to turn the power back down when you switch to 2M. Well, it can’t happen if they are home on the shelf!

More planning: I made sure I had two working sets of headphones and all the needed audio cables and adapters to route the signal from the radio to both of them,

or to an external speaker. One pair needed a little bit of repair work, which was quickly done after testing revealed a problem. I also discovered that my planning/testing was still not as good as it should have been -- although everything seemed to work audio-wise in testing at home, at the Field Day site I discovered that the speakers were not shielded well enough and they howled from RF entering them when we operated on 6M with the antenna turned to anywhere within 45 degrees of the direction between the tower and the operation trailer. Oh well, we could do without the speakers and use the headphones 100% of the time, and so that’s what we did.

Yet more planning: I made sure I had a set of CW paddles, so as to not miss the opportunity to make a one point SSB QSO into a 1+2 point SSB+CW QSO pair, as has happened in years gone by. And yet more inadequate planning: my MFJ memory keyer had been malfunctioning since the June VHF contest two weeks earlier. I worked on it for a while and thought I had everything fixed, but when I got out to the Field Day site and plugged the radio into the keyer, the radio went into sustained transmit mode as if the keyer output was shorted. Grrr! Fortunately, the FT-847 has a very usable built-in keyer that worked just fine with the CW paddles plugged directly into the radio. But of course, it had no option to store a string in a memory location and send a CW sequence with the touch of a function button. Or the ability to send perfect CW by typing on a computer keyboard instead of actually working the paddles. In case you haven’t guessed, my CW skills leave a lot to be desired, but I think I probably made about 5x to 10x as many CW contacts this year than I have

in any previous year, in spite of the lack of computerized assistance, so at least I’m getting a little better.

So how did we do?

I was modestly successful on AO-7, but there were a number of Mode A passes and I had no 10M antenna to work those with. I seemed to struggle a bit to match my uplink and downlink frequencies but there were usually plenty of stations that I could hear clearly in the passband on the Mode B passes.

I was not at all successful on FO-29. This was a bit of a surprise to me since I have worked it quite a few times from home with the same radio plus preamps and power amps as needed plus un-butchered antennas that do not elevate. Passband activity seemed light, signals to me were weak and I never managed to hear my own echoes during any of the passes. It does seem to be true that mode V/U is harder to operate than mode U/V, at least with my limited experience.

I was absolutely astounded by VO-52. This was my first chance to try working it. On the first pass, I realized that I was not prepared for VO-52. Oops, another planning/preparation failure! I hadn’t programmed its frequencies into any of the FT-847 memories, but before the first pass had been underway for even 2 minutes, I quickly looked up the uplink and downlink frequencies in my Palm Pilot (of course!), and punched them into the radio and hit the memory-store button. I heard a lot of incredibly strong signals in the passband, my own echoes were crystal clear and easily found, even when I turned the power level way down, but much to my surprise on the first two passes, I could not work anyone.

Although there were obviously a lot of strong signals in the passband, I could not hear any of them clearly except for my own echoes, and it was obvious that no one was hearing me. By the third pass, it finally dawned on me that I had programmed the sidebands backwards -- instead of LSB transmit/USB



... continued on page 30

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Working the Satellites – Mobile

Pedro A. Perez Alvarez-Cienfuegos, EB4DKA, eb4dka@amsat.org

Grid: IM78cx

Following my experiments with the AO-40 satellite from my mobile station, I decided to try the other birds (especially Fuji-Oscar 29). I have written this article because my mobile station arouses the curiosity of many hams.

I have installed a second hand Kenwood TM-255E VHF multimode transceiver with a VHF mobile whip on the roof of the car. I use this setup for local QSO's and repeaters. But, with the help of my little Kenwood TH-F7E (the European version of the TH-F6A) along with a long rubber whip and a pair of earbuds, I can work satellites too.



Photo 1: Pedro, EB4DKA, works the satellites mobile from his car.

To work the wonderful FO-29 satellite I must stop the car so that the driver's window has a clear shot at the satellite path (Photo 1). I then try to tune a station and look for the best position (polarization) of the HT antenna to achieve the best signal and, with my fingers (Photo 2), tune the HT to a clear frequency. Tune the TX to the equivalent frequency (this requires a little practice) and if you hear your



Photo 2: Pedro tunes his uplink to the correct frequency.

own signal you can start calling CQ. You must follow the Doppler shift by tuning the receiver (very fast in overhead passes!).

I usually work transatlantic QSO's and I accomplished my LEO distance record with this setup (IM78 to EN53 - 6690 km with Dan, AJ9K). I've worked (when FO-29 is in apogee) K3SZH, W4MVB, N4QWF, WB2BUR, KB2YCC, W1FC, VA3DB, WA2EHL and others and can work passes from 2 degrees maximum elevation.

I've tried other receivers but they don't perform for me as well as the TH-F7E:

- The Yaesu FT-817: Although this rig has a very nice SSB receiver, it suffers a strong intermodulation when I try to transmit on VHF (S-meter measures 9+). I have done this test with the FT-817 self powered. The rig is also big and heavy to operate with one hand.
- The Icom IC-R10: This radio is much less sensitive than the TH-F7E and also suffers from strong desensing when I transmit on VHF.
- The AOR 8000: Worst UHF SSB sensitivity and severe desensing when TXing.

This looks like a hard work, but with a little practice it is very easy and gives you a lot of fun. Of course you can work the FM birds with the same procedure.

If you have a multiband-multimode rig (FT-100, IC-706, FT-857, etc.) installed in your mobile you can also try to work the U/V linear birds (VO-52, AO-07).

Remember that you need to have a clear path to the satellite and you must work in a place that is as clean as possible from other RF sources (pagers, cellular repeaters, commercial and broadcast repeaters) to avoid intermod.

I would like to thank the help provided by Juan, EA4CYQ, in my mobile tests and to all the stations who have worked me.

Hope to hear you soon from mobile on satellites!

See my Web site at: <http://www.eb4dka.tk>



receive, I had them set the opposite way. No wonder I could not understand anyone except myself and no one could understand me. As soon as I realized the mistake, I quickly hit the necessary buttons to flip the sidebands and store the new configuration and I was in business! These QSO's were the easiest satellite QSO's I have ever made. All I can say is Bravo to the VO-52 team. This satellite is a real winner!

I can't give you actual numbers of QSO's at this point. We used WriteLog for logging all 5 radio stations with all stations connected to a wireless network. The overall Field Day site manager grabbed all the log files and took them with him for processing. But I do know that we made far more satellite QSO's this year than at any time since I have been coming to Field Day with the Twin Cities Repeater Club. It was a great deal of fun.

And what about the other aspects of Field Day?

Our group really does treat it as the main Ham Radio social event of the year, and we lived up to that intention this year again. Lots of folks came out, lots of socializing occurred, lots of inactive hams got active, lots of "newbies" got on the air for the first time in a contest situation or for the first time on HF. And a LOT of folks were fascinated by the sight of the VHF antennas moving up and down as I tracked satellites, as well as the idea of rock-solid signals stretching between Minnesota and Texas or Florida on the 2M and 70cm bands. I had a lot of folks stop by the VHF station and most of their questions were about the satellite stuff, not about the general VHF/UHF terrestrial stuff. So, I know that our Field Day was a big success this year, even though I don't yet know the point total. And that's the way we planned it, right from the start. 🌐

K9DID

by Emily Clarke, W0EEC, w0eec@amsat.org

It is with great sadness I have to announce that Ben Wright, K9DID, of Appleton, WI has become a Silent Key. Ben (AMSAT member #4050) passed away suddenly on the morning of the 27th of September 2005 while surf fishing in Lake Michigan with his brother-in-law Ron Gorzynski, K8DID (AMSAT LM 1514). Ben was 65 and was an AMSAT member back to 1972 when he and Ron became hooked on satellites while working AMSAT-OSCAR 6.

Many will remember Ben as the chief founder (he would say instigator) of "The DID's" when he received KN9DID as his novice call in Junior High. In 1962 when Ben served in the Coast Guard aboard the USS Mesquite, where he met Ron who also wanted to become a ham. They became friends (against the objections of Ron's wife Bonnie.) Ben elmered Ron who became a ham and in exchange Ben became Ron's brother-in-law when he married Bonnie's sister Sue.

In addition to Ben and Ron, the DID's include K7DID (Deanna - Ron's daughter), KA8DID (Bonnie), K5DID (Deanna's husband Art),

all of whom are AMSAT members. By extension the DID's also includes the many associates who Ben has elmered through his many years as a ham.

Ham radio will mourn his loss. Whether you met Ben on the birds, on the air, at a hamfest or in the AMSAT booth at Dayton, he was fun to be around. He had the exuberance of a new ham, and his passion for amateur satellites was infectious. Ben was a VEC, ARRL Life Member and a member of many other wireless organizations. He was looking forward to celebrating 50 years in Amateur Radio, and his article "It's All My Mother's Fault" will appear in the next edition of CQ magazine.

The DID's have a Web site located at: <http://allfortheunion.com/DID/index.htm>

Ben is survived by wife Sue, daughter Allison and son Jason. Deanna, K7DID, has started a thread in the eHam "Friends Remembered" section for those who would like to share their remembrances.

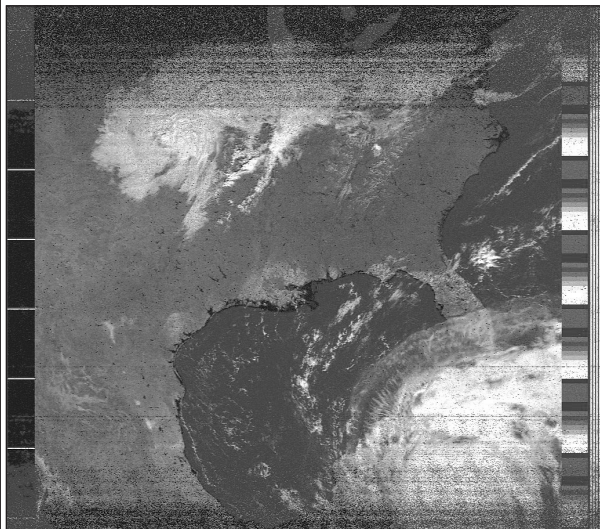
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An Interesting Antenna



Jerry Martes copied the picture below of hurricane Wilma on October 20th at his home on the west coast with the antenna shown at below left. The maximum elevation of the NOAA-17 satellite was 4 degrees above the horizon. The portion showing the hurricane was about 2 degrees elevation proving that his antenna works very well. Jerry is writing an article about his antenna and I hope to have it in an upcoming issue. He'll show how to cut it for the amateur satellite bands. You can contact Jerry at j.jmartes@verizon.net.

Ed Long, WA4SWJ ☺



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